FIRE REHABILITATION MONITORING OF BLM LANDS AFFECTED BY 1996 FIRES

FINAL REPORT

Interagency Agreement J910A70026,
USDI Bureau of Land Management (Utah Fillmore Field Office)
and USDA Forest Service (Rocky Mountain Research Station)

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August 2001

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ACKNOWLEDGEMENTS

These studies were funded by the Utah State and Fillmore Field Offices of the USDI Bureau of Land Management. Earl Hindley, Pat Fosse, Harvey Gates, John Shive and Melanie Mendenhall of the Utah BLM provided support for these studies. John Proctor, Justin Williams, and Lacey Cluff collected data for the Extensive Study. Stewart Sanderson, Lans Stavast, Alex Parent and Steve Otero assisted in field data collection for the Intensive Study. Kimball Harper, Bruce Roundy, and Sheldon Nelson provided technical support.

INTRODUCTION

This report is a summary of results of the fire rehabilitation monitoring study that was initiated in 1997 by interagency agreement between the USDA Forest Service (Rocky Mountain Research Station Shrub Sciences Laboratory) and the Bureau of Land Management. The purpose of this study was to document vegetation patterns and trends following 1996 summer wildfires impacting BLM lands in Utah, primarily lands administered by the BLM Fillmore Field Office. Rehabilitation treatments including aerial seeding, chaining, and rangeland drill seeding were carried out by the BLM following these fires. The effects of these treatments were documented and compared. Untreated and unburned areas were also studied.

This report builds upon two other reports, previously submitted to the BLM in March 1998 and April 1999. These previous reports described methods of data collection used in the study, and presented initial results following the first and second field seasons of data collection (1997 and 1998). The current report incorporates data from additional field seasons (1999, and 2000 for some study sites), and also includes methods and results from a companion study initiated by BLM worker Don Proctor in 1997. Proctor's study sought to document the post-fire vegetation response at sites representing all the 1996 fires, rehabilitation treatments, and seed mixes used by the Utah BLM. In 1999, the BLM Fillmore Field Office recruited Justin Williams and Lacey Cluff to recollect data from Proctor's study sites in Millard and Juab counties. The work of Proctor, Williams, and Cluff at these study sites is referred to here as the "Extensive Study", while the authors' work is referred to here as the "Intensive Study." Datasets of the Extensive and Intensive studies were not combined because of variation between them due to the different observers and methods employed in each study.

A master's thesis drawn from the Intensive Study was completed by the primary author at Brigham Young University (Ott 2001). This thesis focused particularly on the comparison of chained and non-chained areas. Another publication, which appears in the proceedings of the Rocky Mountain Research Station 11th Wildland Shrub Symposium (Ott et al. 2001), focuses on the comparison of burned and unburned areas. Results presented in these other publications are not emphasized in this report.

The principal objective of this report is to provide a comprehensive data summary and highlight differences in the effects of rehabilitation treatments at different study sites. The graphs and tables presented were designed for ease of visual comparison and information retrieval. Photos were selected from a photo database to illustrate certain points. In this report we also present the results of statistical analyses that were used to search for predictive patterns in the data. The information of this report should be useful for future fire rehabilitation planning and other land management activities in the region of this study.

PART 1: INTENSIVE STUDY

METHODS

The seven Intensive Study sites are listed and described in Table 1. These sites were selected by the authors in 1997, based on accessability and the presence of two or more treatments in close proximity. Table 1 also lists the treatments present at each study site, and Table 2 defines these treatments. A chained treatment (burned/aerially seeded/chained) and a non-chained treatment (burned/aerially seeded/not chained) were present at every site. Figure 1 shows the location of the study sites relative to the 1996 fires in Juab and Millard counties.

Five of the Intensive sites were set up near cadestral survey markers (Table 1), and these markers were used as reference points. Metal pegs were placed arbitrarily to mark reference points at sites lacking such markers. Transect lines were extended directly from the reference point, or otherwise arranged systematically within the different treatment areas of the site. Most transect lines followed cardinal compass directions, or were arranged parallel to the boundary between treatment types. Plots were established at regular intervals of 50 meters (Twin, Gilson, Dog Slopes, and Railroad sites), or 60 meters (Jericho and Paul Bunyan sites) along the transect lines. A metal peg served as the center of a circular plot with a radius of 5.6 meters and an area of 100 m^2 (0.01 hectare or 0.025 acre), and also served as the southwest corner of a square-shaped, 1 m^2 plot. The boundaries of the circular plots where measured and marked at the time of data collection and the 1 m^2 plots were defined using a PVC pipe frame.

Four plots (i.e., 1 m^2 plots nested within 100 m^2 plots) were placed within each treatment at each site. Additional plots were placed in some treatments of the Cunningham and Jericho sites. The Cunningham chained and non-chained treatments were expanded to five plots, because the fourth plot of each treatment was positioned in a wash that poorly represented the entire area. Plots 5 and 6 were added to the Jericho non-seeded treatment, to represent a hilltop environment more similar to the chained treatment plots than non-seeded plots 3 and 4. In 1998, even more plots were added to the Jericho study site, for the purpose of documenting this site in greater detail. Eight new plots were placed in the Jericho chained treatment in 1998, bringing the total number of chained plots to 12, and two additional plots were placed in the non-seeded treatment, bringing the total number of non-chained plus non-seeded plots to 12. The non-chained and non-seeded treatments were merged for this comparison after it was found that seeded plants had established in many non-seeded plots, owing to drifting seed. A schematic map of the layout of transects and plots at the Jericho site is shown in Figure 2. Similar maps of other Intensive Study sites were included in the March 1998 report.

Percent cover by type was estimated for the large (100 m^2) plots at all sites. Total plot area was visually divided between vascular plants (excluding mature trees), bare soil, litter, rock (<2cm), and cryptogams, with percent foliar vascular plant cover estimated first, and the remaining plot area assigned to the other categories to bring the total to 100%. Litter was defined as any herbaceous material from a previous growing season, and any dead woody material in contact with the surface of the ground, including fallen branches and bases of dead trees. Vascular plant cover was subdivided into four categories: trees, shrubs, forbs, and grasses. These categories were recorded as relative percent cover in the field (i.e., the four categories totaled 100% for each plot), but were subsequently converted to actual percent cover by scaling their values to the total vascular plant cover. The grass category was further subdivided into seeded grasses (species included in the rehabilitation seed mixes), native grasses (native perennial species naturally occurring on site) and exotic grasses (non-native annual grasses, dominated by cheatgrass, *Bromus tectorum*). These were also recorded in the field as relative cover but later were converted to absolute cover.

The tree category referred only to trees (primarily juniper and pinyon) less than a meter tall. In the burned areas sampled, no live trees exceeded this size, but in unburned areas, mature trees were present which were considered separately in a canopy cover estimate. Canopy cover of dead tree skeletons in the burned areas was also measured, by estimating the amount of ground that would have been covered by these trees if they were foliated. Where these tree skeletons had been knocked over by chaining, canopy cover was estimated for the tree in the fallen position.

Composition and cover of individual vascular plant species was recorded for both plot sizes. Plants were recorded if their canopy occurred inside the plot boundary, even if not rooted in the plot. Each species present in the large (100 m^2) plots was assigned to one of the following cover classes: <1%, 1-5%, 6-25%, 26-50%, 51-75%, 76-95%, >95% (modified from Daubenmire 1959). Species nomenclature followed Welsh et. al. (1993) except for certain grasses, where traditional names were used: *Agropyron elongatum, Agropyron intermedium, Agropyron spicatum, Agropyron smithii, Agropyron trachycaulum, Oryzopsis hymenoides,* and *Sitanion hystrix* (Vallentine 1961). Certain taxa were lumped together because of identification difficulties in the field. All varieties of crested wheatgrass were placed together as *Agropyron cristatum*; intermediate, pubescent, and tall wheatgrass where combined (*Agropyron elongatum/ intermedium*); and Russian wildrye (*Elymus junceus*) was combined with Basin wildrye (*Elymus cinereus*), the latter of limited occurrence at any of the Intensive Study sites.

For the small (1 m^2) plots, percent cover by type was estimated as in the large (100m^2) plots for vascular plants, bare soil, litter, rock, cryptogams, and dead tree overstory. For each vascular plant species with cover in a small plot, percent cover was estimated to the closest whole

number. Rooted density counts were also recorded for each vascular plant species in the small plots. The counts were rounded to the nearest five or ten when the number of individuals exceeded fifty. For perennial grasses, continuous clumps were counted as single individuals.

Plot data as described above were collected each year for three consecutive years (July-August 1997, June-early July 1998, and late June-early August 1999). Additional data were collected from some plots of the Jericho and Railroad sites in 2000. Photographs where taken of both large and small plots during each year, and qualitative notes were taken relative to site conditions, grazing, etc. In 1997, slope was measured for each plot using a clinometer, and aspect using a compass set at an inclination of 15°, both measured along a line extending through the large plot center from the upslope edge to the lower edge of the plot.

In addition to the plot data described above, step-point data were collected in 1998 and 1999. In 1998, four step-point transects of forty points per transect were taken per treatment at each site. Each transect began at the edge of one of the large plots and extended in a straight line away from it, usually along the same transect lines upon which the plots had been placed. In 1999, step-point data were collected at only some of the sites and treatments: Dog Slopes, Paul Bunyan, Gilson chained and non-chained, Jericho drilled and non-chained (east of U.S. Highway 6 only), and Railroad late-chained (chained in 1999 two years following the fire; see discussion below). The 1998 step-point transects for these sites and treatments were repeated in 1999 along approximately the same lines. Additional transects, positioned at 90° from the original transects, were also taken in 1999 at all of the mentioned sites and treatments except for the Railroad late chained.

Step-point data were collected according to a modified version of the technique of Evans and Love (1957). After the direction of a transect line was determined using a compass, one worker stood as a reference point as the other worker walked toward him with paces of approximately one meter. Data points were recorded with each step. If a tree or tall shrub was encountered along a transect line, the line was maintained by extending a meter-stick, from point to point, along the ground or through the canopy, then resuming paced steps on the opposite side of the tree or shrub. If the boundaries of a treatment area were reached before a transect line was complete, a turn of 135° was made, and the step-points thus continued without interruption within the appropriate treatment area. At each step point, a pin (2 mm diameter wire attached to the end of a meter-stick) was lowered to the ground directly in front of the recorder's boot. Basal cover at the intersection of the pin with the ground was identified as bare soil, rock, litter, cryptogam, or a species of vascular plant. Litter was defined to include dead wood at ground level and dead herbaceous material from a previous year, including dead sheaths and culms surrounding perennial bunchgrasses. At points where vascular plant cover was not present basally, the nearest rooted

plant in a 180° arc was recorded, so that a dataset of relative composition could also be complied. Canopy composition was also obtained at each point by recording any plants touching or above the meter-stick, vertically positioned above the point. Tree overstory was recorded at points lying beneath living trees or beneath the frame of burnt trees, standing or fallen.

At the same time that step-point data were collected in 1998, tree density was measured by counting tree bases located within two meters on either side of the step-point transect lines. Tree density per hectare for each treatment area could then be estimated based on counts within these 4m by 400m belt transects. Live trees or dead burned trees were counted, depending on the treatment type. In chained treatments where the dead trees were no longer standing, tree bases lying within the zone were counted.

RESULTS

Mean percent cover values for the Intensive Study are summarized in Tables 3-5 (two pages each). The values shown in these tables are mean percent cover of four plots for the treatment, site, and year indicated. Note that means for Cunningham chained and Cunningham non-chained are based on plots 1, 2, 3, and 5, and Jericho non-seeded is based on plots 1, 2, 5, and 6, for reasons described above. Mean cover values for small (1 m^2) plots are shown in parentheses to the right of means for large (100 m^2) plots. Also note that all values are rounded to the nearest whole number, and a "+" symbol is used to indicate trace amounts of cover which did not round up to one percent. Table 3 summarizes mean percent cover of cover categories (bare soil, litter, rock, cryptograms, vascular plants, shrubs/trees, forbs, exotic grass, seeded grass, native grass, and dead tree canopy). Table 4 summarizes mean percent cover of important seeded species (crested wheatgrass, intermediate/tall wheatgrass, smooth brome, Russian/basin wildrye, alfalfa, and yellow sweetclover), and also information concerning the varieties and seeding rates reportedly used at each site. Large plot mean percent cover of miscellaneous important species and genera is summarized in Table 5. Cover of cheatgrass, the dominant invasive species, is shown for comparison in the right hand column of both Table 4 and Table 5.

Part of the information contained in Tables 3-5 is shown pictorially in Figures 3-4. Large plot mean categorical cover values from Table 3 are stacked in the bar graphs of Figure 3 (two pages), where individual bars show each treatment/site/year combination. Mean percent cover of important seeded species, native grasses, and cheatgrass from Tables 4-5 are shown in Figure 4 (two pages), for the chained (Fig. 4a), non-chained (Fig. 4b), drilled, seeded slopes, and non-seeded (Fig. 4c) treatments. Following these graphs in the figures section are a series of photographs (Fig. 5-13), discussed below. Also contained in this report, in Table 6 (four pages), are results of the 1999 step-point transects. For each species recorded in these transects, mean

cover (basal, canopy, and relative) is shown by site. The 1998 step point data are not presented here but were presented in the April 1999 report.

Mean cover values for the large plots, small plots, and step-point transects are different because these values were obtained using different methods on spatially-different portions of the study areas. For the large plots, mean cover values for vegetation categories (Table 3, Fig. 3) do not agree exactly with aggregate values for individual species within these categories (Tables 4-5, Fig. 4), because these values were measured and calculated in different ways (i.e., values for individual species were based on cover class midpoints while values for vegetation categories were based on direct cover estimates). Nevertheless, there is general agreement in the results of these methods, and in combination they tend to support similar conclusions regarding differences between treatments and sites and trends between years.

Tables 7-8 show results of the expanded plot samples comparing chained and non-chained (including non-seeded) treatments at the Jericho site. Cover categories are shown in Table 7, and cover of individual species in Table 8. These data were collected in 1998, 1999, and also 2000. The 1999 data were collected shortly before the "Railroad" fire consumed the west part of this study site in early July 1999. Consequently, comparisons of the 1999 and 2000 data reveal the effects of this fire. Two non-chained plots east of U.S. Highway 6 at the Jericho site did not burn in the 1999 fire, and for this reason were not included in the non-chained/non-seeded summaries shown.

DISCUSSION

The Intensive Study revealed differences between burned and unburned vegetation (Ott et al. 2001) and chained and non-chained treatments (Ott 2001). The chained, drilled, and old seeding treatments consistently had higher cover of seeded grasses than non-chained and non-seeded treatments, although the actual percent cover of seeded grasses in these treatments differed by site (Fig. 3-4; Tables 3-4). In chained and drilled treatments, seeded grass cover increased at all sites between 1997 and 1998 (Fig. 3-4; Tables 3-4), influenced by a period of above-average precipitation (Fig. 14). Between 1998 and 1999, seeded grass cover in these treatments increased at a slower rate or decreased slightly (Fig. 3-4; Tables 3-4). Exotic grass (cheatgrass) also increased in cover between 1997 and 1998 at most sites, and was especially prominent in non-chained and non-seeded treatments (Fig. 3-4; Tables 3-4). At some sites and treatments, cover of new cheatgrass plants declined between 1998 and 1999, although litter from the previous year's cheatgrass increased (Fig. 3-4; Tables 3-4). 1999 step-point data show higher cover of cheatgrass in the non-chained treatments of the Dog Slopes, Gilson, and Paul Bunyan sites (Table 6a-c). The 1999 step point data show conspicuously higher cover of seeded grass

species in the chained than the non-chained treatments (Table 6a-c), except for tall and intermediate wheatgrass at the Dog Slopes site, which had high cover in the non-chained treatment (Table 6a) where they had established readily under dead trees.

The Cunningham site stood apart from the other sites because of its location, type of rehabilitation treatment, and grazing management following the fire. This site is located in the Cedar City BLM district, immediately west of the rest stop on Interstate 15 near mile 126. The seed mix used at this site included forage kochia and Wyoming big sagebrush, which were aerially seeded during the winter after initial seeding and chaining had been done. The initial seed mix included Indian ricegrass as well as standard grasses and forbs such as smooth brome, crested wheatgrass, intermediate wheatgrass, and alfalfa. The Cunningham site also differed from study sites of the Fillmore Field Office in that chaining had been done using a smooth chain rather than an Ely chain. Establishment of seeded grasses was lower at the Cunningham chained treatment than at chained treatments of other sites, possibly because of less effective seed coverage with the use of a smooth chain. Establishment was low for Indian ricegrass (most of the observed cover appeared to be residual plants from before the fire), but establishment was higher for big sagebrush and prostrate kochia. Big sagebrush became established in the non-chained and old seeding treatments as well as the chained treatment. By 1999, the mean number of sagebrush plants per 100 m^2 plot at the Cunningham site was 20 for the chained treatment, 5.4 for the non-chained treatment, and 8.5 for the old seeding treatment. Between 1998 and 1999, big sagebrush plants increased noticeably in size, but cover of other seeded plants and cheatgrass decreased (Fig. 5). Heavy grazing at the Cunningham site after 1998 appears to have been the primary factor causing these changes.

A reduction of vegetation cover between 1998 and 1999 was also observed at the Twin site drilled treatment (Fig. 6). Seeded alfalfa and yellow sweetclover responded well to the high moisture of 1997-1998 (Fig. 14), but subsequently declined dramatically, probably because of a combination of drought, grazing, and grasshopper infestations. The nearby chained treatment of the Twin site also yielded high cover of seeded species, mainly grasses, in 1998. Intermediate wheatgrass had the highest cover here, even though crested wheatgrass had been seeded at a higher rate (Table 4). Vegetation cover at the Twin chained treatment remained high in 1999 (Fig. 6).

Figures 7-10 show photographic histories spanning four years for some of the plots of the Jericho study site. Figures 7 and 8 give broad and close-up views of a plot in the chained treatment at the Jericho site, while Figures 9 and 10 give similar views of a plot in the nearby non-seeded, non-chained treatment (located in the right-of-way of U.S. Highway 6 near milemarker 124). These photographs illustrate the contrast between perennial grass stands resulting from

seeding and chaining, and the annual dominance that may result in the absence of treatment. Comparison of the 1999 and 2000 photos in Figures 7-10 reveals effects of the 1999 "Railroad" fire. Following the fire we recorded higher bare soil and exposed rock, and lower cover of vascular plants, litter and cryptogams, in both chained and non-chained treatments (Table 7). The 1999 fire cleared these plots of cheatgrass litter, and in 2000 cheatgrass cover remained much lower than it had been previous to the fire (Tables 7-8). Since no new rehabilitation was done at this site following the 1999 fire, the 2000 cover of seeded grasses was the result of resprouting or new recruitment from previously-established plants. Foliar cover of seeded grasses decreased considerably between 1999 and 2000, but remained higher in the chained plots (Tables 7-8).

A four-year history of a plot at the Railroad site is shown in Figures 11 and 12. This plot was aerially-seeded but not chained following the 1996 fire. As the 1997 and 1998 photographs show, some seeded grasses became established here, but cheatgrass became dominant over most of the area. Between 1998 and 1999, an attempt was made to rehabilitate this area through prescribed burning, a new aerial seeding, and double-pass chaining. The 1999 and 2000 photos of Figures 11 and 12 show the level of effectiveness of this treatment in replacing cheatgrass with perennial grasses. In Figure 13, also taken at the Railroad site, the initially non-chained treatment is shown on the left, and the chained treatment on the right. In the 1998 photo of Figure 13, the non-chained treatment had been chained, and the original chained treatment had recently been burned in the 1999 fire. The fire stopped abruptly at the boundary between these treatments because the recently-chained treatment on the right had not yet developed sufficient cover to carry the fire. The 2000 photograph of Figure 13 shows recovery of this burned vegetation following the fire.

Further discussion of Intensive Study results can be found in previous reports and the manuscripts cited in the introduction of this report.

PART 2: EXTENSIVE STUDY

METHODS

Site Layout and Data Collection

The Extensive Study covered greater number of sites than the Intensive Study, although many of these sites were represented by only a single transect within a single treatment. A total of 17 chained transects, 15 aerially-seeded transects, 16 drilled transects, and 4 non-seeded transects were established in Juab and Millard counties by Don Proctor in 1997 (Table 9). Each transect was placed along a line between a reference post and a prominent landmark, such as a mountain peak. Distances were measured in English units; the distance from the reference post to the first plot center was 65 ft. (19.8 m), and subsequent plot centers were separated by 100 ft. (30.5 m).

Nested plots of two sizes were used for vegetation sampling in the Extensive Study. The large circular plots were 100 m^2 in size, as in the Intensive Study, but the small plots were 3 ft. by 3 ft. (0.837 m^2) in size. For the large plots, percent cover estimates were made using the same system as the Intensive Study, for the following categories: bare soil, litter, rock (>1 cm), cryptogams, total vascular plants, trees, shrubs, forbs, total grasses, seeded grasses, native grasses, and exotic annual grasses (i.e., cheatgrass). The grass and other vascular plant categories were measured as relative cover in the field but were subsequently converted to absolute cover.

In 1997, the boundaries of the large-plots were estimated rather than marked, and general descriptions of plant species composition, soil erosion, grazing, and other site conditions were made. The only data collected from the small plots in 1997 were density counts of seedlings of seeded shrubs, seeded grasses, and seeded forbs, not identified to species. In 1999, a more complete documentation of plant species within the large and small plots was carried out, and the methods that had been used in the Intensive Study were followed more closely. As in the Intensive Study, varieties of crested wheatgrass were not distinguished, and intermediate, pubescent, and tall wheatgrass where lumped. Russian wildrye and Basin wildrye were treated separately.

A GPS unit was used to determine latitude, longitude, and elevation of each transect reference point of the Extensive Study. Tree density was measured in 1997, by counting the number of dead tree bases in belt transects (3 m by 400 ft.) that corresponded to the transect lines upon which the plots had been placed. Juniper and pinyon were differentiated in these tree density counts. Slope and aspect were measured at each plot in 1999 using the same methods as the Intensive Study. No step-point data were collected at the Extensive Study sites.

Data Analysis

Various approaches were used to retrieve information from the mass of data collected in the Extensive Study. One approach was to take the measured cover variables and average them across the four plots of each transect for each year, then use these values to visually compare treatments, sites, and years. Another approach involved analyses of variance to assess the overall effects of treatment and year across sites. The multivariate nature of the data also made it possible to employ classification techniques to search for patterns among variables. Each of these approaches and their results are discussed in turn below.

Analyses of variance were performed using the PROC GLM procedure of SAS® statistical software (SAS Institute, Inc. 1990). We ran two-factor analyses of variance with treatment as one factor with three levels (aerial-seeded, chained, and drilled treatments) and year as another factor with two levels (1997 and 1999). Tukey's HSD procedure (Steel and Torrie 1960) was used for mean separation of treatment main effects and interactions. Five cover variables--total vascular plants, forbs, seeded grass, native grass, and exotic grass, as measured in the 100 m^2 plots--were tested using this model following an arcsine of the square root transformation (Steel and Torrie 1960).

The relationship between cover variables and other measured variables was explored using CART®, a data-mining procedure (Breiman et al. 1984, Steinberg and Colla 1997). This procedure searches for a suitable predictive classification model for a response variable using a set of predictor variables. The response variables of interest were cover (100 m^2 plots) of certain vegetation types and species (e.g., vascular plants, seeded grass, native grass, exotic grass, crested wheatgrass, intermediate wheatgrass, cheatgrass) considered separately by year. The predictor variables used included elevation, slope, aspect, juniper density, pinyon density, total tree density, dead tree canopy cover, 1997 litter cover and 1997 rock cover. Measurements of these variables had been taken for each 100 m^2 plot, except for elevation and tree density (including juniper density and pinyon density), which had a single measurement per site or transect. These predictor variables were all on a ratio scale except aspect. In one set of CART analyses, aspect was divided into eight categories (compass directions), and in another set of analyses was divided into two categories (north-facing and south-facing[1]). Treatment (chained, drilled, or aerial-seeded) also served as a categorical predictor variable in these analyses. In cases where seeded species cover was the response variable, two other predictor variables were added: timing of seeding (fall, early spring, or spring), and seeding rate in lbs/acre of the species or group.

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[1]"North-facing" aspect was defined as the arc from west-northwest to east; "south-facing" aspect was defined as the arc from east-southeast to west.

RESULTS AND DISCUSSION

Comparison of Extensive Study Sites

In this section we present and discuss data for individual transects and sites of the Extensive Study. Readers without familiarity or specific interest in these sites may wish to skip to the "Statistical Analyses of Extensive Study" section, which gives a broader, statistically-defined view of the study.

Tables 9-16 present data for the Extensive Study in a manner similar to the way data are presented in the tables described previously for the Intensive Study (i.e., Tables 3-5). Transects of the Extensive study are listed alphabetically under treatment headings (chained, aerial-seeded, and drilled) in these tables. Table 9 summarizes location, elevation, slope, aspect, tree density, tree canopy, grazing intensity and dates of data collection for these transects. Soils of each transect, as interpreted from soil survey maps, are shown in Table 10. Table 11 shows mean percent cover by category for both 1997 and 1999. Table 12 gives mean percent cover of important seeded species and cheatgrass (for 1999 only) along with information on the varieties and seeding rates reportedly used at each site. These means are based on the midpoints of the cover classes that had been recorded for each species. Note that means of small (1 m^2) plots are shown in parentheses to the right of means of large (100 m^2) plots in Table 12. In Table 13, mean percent cover (large plots only) of miscellaneous important species and genera are summarized. Table 14 summarizes small-plot total density counts for seeded plants, to the level of detail recorded in 1997 and 1999. Tables 15 and 16 provide the same type of cover data as Tables 11 and 12, but for non-seeded transects not shown in the other tables. These non-seeded transects had each been paired with drilled transects, which are also shown for comparison in Tables 15 and 16.

Part of the information contained in Tables 11-16 is shown pictorially in Figures 15-16. Large plot mean categorical cover values from Tables 11 and 15 are shown in the bar graphs of Figure 15 (three pages). Figure 15 shows each treatment on a separate page, with 1997 data on the upper graph and 1999 data on the lower graph of each page, and with sites arranged from left to right in a sequence that corresponds approximately to the actual north to south position of these sites relative to each other. Large-plot mean percent cover of important species (seeded species, native grasses, and cheatgrass) from Tables 12, 13, and 16 are shown in Figure 16 (three pages), where treatments and sites are arranged as in Figure 15, but data are from 1999 only. Note that means for individual species in Figure 16 are not numerically equivalent to the 1999 means for vegetation categories in Figure 15, because the former were obtained using midpoints of cover classes, and the latter were separately obtained using direct estimates of percent cover.

The individual species means based on cover class midpoints tended to be higher and are probably less accurate than the vegetation category means. Nevertheless, both sets of data show similar patterns for different sites and treatments.

In the text that follows, some of the patterns and trends evident from the Extensive Study data are highlighted, and explanations for some of these patterns and trends are offered. Because the authors of this report were not directly involved in data collection for the Extensive Study, this discussion is based on examination of the data, photographs, maps, soil surveys, and on the authors' experience. Don Proctor and Justin Williams provided input and clarification. The explanations offered below should be considered possibilities that may require further field investigation to verify. The discussion below proceeds geographically from burned areas on the north end of Juab county to burned areas on the south end of Millard county.

Boulter, Pole Canyon, and Northern Little Sahara Complex

The four chained transects of this area (Boulter-2 and -53, South Eric/Pole Creek-19, and North Cherry-48) were located above 6000 ft. elevation (Table 9) and had relatively high establishment of seeded grasses (Fig. 15a; Table E2). Boulter-53 stands out for having the highest mean cover of smooth brome and Russian wildrye of any chained transect in 1999 (Fig. 16a; Table 12). The higher elevation (6550') and high dead tree canopy cover (23%) at plots of the Boulter-53 transect may have been factors influencing the establishment of these grasses at this site. Boulter-53 also had intermediate wheatgrass as well as crested wheatgrass, unlike Boulter-2 which was almost entirely crested wheatgrass, despite having been seeded with the same seed mix (Fig. 16a; Table 12). South Eric/Pole Creek-19 and North Cherry-48 had primarily crested wheatgrass, with some intermediate wheatgrass (the latter was not reported to have been seeded at South Eric/Pole Creek). North Cherry-48 had the highest cover of annual forbs and cheatgrass of the chained treatments of this area (Fig. 16a; Tables 12-13), which may have been related to the position of the North-Cherry plots on steep (10-22%), south-facing, rocky slopes (Tables 9, 11).

The four northernmost aerial-seeded transects (Boulter-3, Sabie-4, Little-Mud-14, and Middle-Mud-16), located on the northwest side of Tintic Valley, had noticeably higher cover and density of seeded grasses than nearly all other aerial-seeded transects (Fig. 15b, 16b; Tables 11, 12, 14). Smooth brome was seeded at these sites and became established along with the co-dominant grasses crested and intermediate wheatgrass (Fig. 16b; Table 12). Although cheatgrass and various species of native grasses were present at these sites, they were relatively minor components (Fig. 16b; Tables 12-13). In contrast, seeded grass cover was low and cover of native grasses and cheatgrass high at two aerially-seeded sites a few miles farther south, Big Mud-

17 and North Eric-51 (Fig. 15b; Table 11). These differences could be related to pre-burn vegetation, or to differences in fire intensity at these two sets of sites. The fires at Big Mud-17 and North Eric-51 were likely of low intensity, allowing survival of cheatgrass seeds and native grasses, which then competed with seeded plants. The presence of residual cryptogams at these sites (Fig. 15b; Table 11) further suggests that fire intensity was low. Fire intensities may have been higher at Boulter-3, Sabie-4, Little-Mud-14, and Middle-Mud-16, where tree canopy cover was also higher. Intense heat in the zone beneath burning trees could have killed understory plants and seeds, and generated soil conditions favorable for the establishment of aerial-seeded grasses. Another factor that could have influenced the outcome of the aerial seeding is the grazing that took place at some of these sites, particularly Little-Mud-14 and Middle-Mud-16, which were reported to have been moderately to heavily grazed in 1997 (Table 9). Grazing could have damaged that year's young seedlings, but also could have improved the seedbed through trampling, such that new seedlings subsequently germinated and established by 1999.

Southern Little Sahara Complex, Cherry Creek, and Black Mountain

The two chained transects on the south side of the Little Sahara complex, South-Mud-18 and Tanner-Creek-6, differed dramatically in seeded plant establishment. South-Mud-18 had the highest cover of seeded grasses of any chained plot (Fig. 15a; Table 11), with near-equal proportions of crested and intermediate wheatgrass (Fig. 16a; Table 12). Unlike the chainings farther north, this site had no trees and occurred at a lower elevation of 5280 ft. (Table 9). Heavy grazing occurred at South-Mud-18 in 1997 and possibly influenced seeded plant establishment in a manner similar to that described above for aerial seedings. In contrast, the chained transect Tanner-Creek-6, at an elevation of 4210 ft., had very poor establishment of seeded grasses and had the highest cover of cheatgrass of any transect in 1999 (Fig. 15a, 16a; Tables 11, 12). Halogeton was present in the Tanner-Creek-6 plots in 1997 but not 1999, and greasewood was present both years (Table 13), suggesting that this site has a history of weed presence and belonged to the climate and soils of the salt desert shrub vegetation type. However, even in the sagebrush-juniper vegetation that was more typical for the study areas, chaining was not always successful. For example, the Big-Cherry-27 chained transect to the west in the Cherry Creek fire had low establishment of seeded grasses and moderately high cheatgrass invasion (Fig. 15a, 16a; Tables 11, 12). At this site, fire intensity appears to have been low, and local soils and precipitation patterns may not have been as favorable to plant establishment as they were elsewhere.

Five transects were located within or adjacent to the Little Sahara Recreation Area, four representing drill treatments (North-Eric/Little-Sahara-25 and South-Eric/Little-Sahara-24, 26,

and 31) and one of an aerial seeding (South-Eric/Black-Mountain-21). The South Eric drilled sites appear to have been seeded with intermediate wheatgrass, even though this was not reported. At South-Eric/Little-Sahara-31, closest to the sand dunes, seeded grass cover was almost entirely intermediate wheatgrass (or, as identified in 1997, western wheatgrass; Fig. 16c; Tables 12-13). Other sites in the vicinity of the dunes, including the South-Eric/Black-Mountain-21 aerial seeding, supported crested wheatgrass in combination with intermediate wheatgrass, and also some Russian wildrye and alfalfa (Fig. 16b; Tables 12). South-Eric/Little-Sahara-24 had the highest cover of seeded plants and lowest cover of cheatgrass of these sites (Fig. 15c; Table 11); this site may have received supplemental seed from aerial seedings on the state section adjacent to it. North-Eric/Little-Sahara-25 and South-Eric/Little-Sahara-26 were located on opposite sides of the road near the entrance to the recreation area. Both seeded grass and cheatgrass cover were relatively low at these sites (Fig. 16c; Table 11), although South-Eric/Little-Sahara-26 had relatively high cover of Russian thistle (Table 13). Soil factors may have influenced the outcome of the drilling treatment at these sites (-25 and -26), which lie on the Shabliss very fine sandy loam (Table 10), a soil which reportedly is poorly suited for range seeding because of a shallow, strongly-cemented silica layer (Trickler and Hall 1984).

Farther east near Jericho Junction, three other drilled transects (North Eric/Little-Sahara-5 and -6 and South-Eric/Little-Sahara-8) lay on soils (Truesdale fine sandy loam and Linoyer very fine sandy loam; Table 10) which are better-suited for range seeding (Trickler and Hall 1984). Yet, these transects had the poorest seeded grass establishment and greatest weed invasion of any drilled sites (Fig. 15c; Table 11). North-Eric/Little-Sahara-5 was located not far from the Tanner-Creek-6 chained transect, which it resembled in having halogeton in 1997 (Table 13) and very high cheatgrass cover in 1998 (Fig. 15c, 16c; Tables 11-13). North Eric/Little-Sahara-6 and South-Eric/Little-Sahara-8 did not have halogeton and had somewhat lower cover of cheatgrass than North-Eric/Little-Sahara-5 (Fig. 15c, 16c; Tables 11-13), but had high cover of tumblemustard in 1999 (Table 4). Litter was high at these sites in 1997 (Fig. 15c; Table 11), suggesting that the fire intensity had been low and conditions were likely ideal for establishment of annual weeds from seed. These sites are located near roads and likely have a long history of disturbance; they were possibly already converted to weed patches before the 1996 fire.

Leamington Complex and Eightmile

Four drilled transects (Leamington-15, 22, 20, and 32) were located in the Leamington complex burn on the southeastern side of Tintic Valley. These drillings had been seeded with higher rates of crested and intermediate wheatgrass than the Little Sahara drillings, and in general the transects revealed higher seeded grass establishment and lower weed cover than the Little

Sahara drilled transects. Of the Leamington drilled transects, the lowest seeded grass cover and highest cheatgrass cover occurred at Leamington-15 (5300 ft. elevation), and with increasing elevation at Leamington-32 (5400 ft.) and Leamington-20 (5660 ft.), seeded grass cover increased while cheatgrass cover decreased (Fig. 15c, 16c; Tables 11-12). However, elevation cannot be the only factor involved in these patterns, because Leamington-22, at 4990 ft., had high seeded grass cover comparable to Leamington-20, at 5660 ft. (Fig. 15c, 16c; Tables 11-12). More cheatgrass may have been present initially at Leamington-15 and -32, because of their close proximity to a highway. Leamington-32 may have also been less suitable for drilling because it occurred on stony soils (Table 10). Nevertheless, exotic annual grass cover decreased at these sites between 1997 and 1999 (Fig. 15c; Table 11), suggesting that the seeded grasses had a competitive advantage in these environments. The drilled transect Leamington-22 had only a trace of cheatgrass in 1999 (Fig. 16c; Table 12), but the adjacent non-drilled, non-seeded transect Leamington-23 was dominated by cheatgrass (Fig. 17c; Table 16).

The chained transect North-Gilson-28 and aerial-seeded transect North-Gilson-29 were located adjacent to each other at the northern base of the Gilson Mountains, at 5790 ft. elevation on east-facing, 11-20% slopes (Table 9). This site demonstrated the expected greater cover of seeded plants in the chained transect and greater cover of cheatgrass in the non-chained. Seeded cover in both treatments was divided evenly between crested wheatgrass, tall wheatgrass, and alfalfa (Fig. 16a-b; Tables 12-14), the latter apparently having drifted from an aerial seeding on a nearby state section. Smooth brome was reportedly seeded here but was not recorded as present, unlike the Intensive Study Gilson site three miles to the east where smooth brome became well-established (Fig. 4a).

The five aerial-seeded transects on the south side of the Leamington complex (South Gilson-41, Sevier-Sara-49, Sage-Valley-50, West-Fork-34, and West-Fork-33) had relatively low cover of seeded grasses, and exotic annual grass cover increased at these transects between 1997 and 1999 (Fig. 15b; Table 11). Cheatgrass cover was highest at Sevier-Sara-49 (Fig. 15b, 16b; Tables 11-12), a degraded treeless site near the Sevier River. The other sites had dead tree canopy ranging from 10-17% (Table 9), and also had varying amounts of native grasses (Fig. 16b, Table 13). West-Hills-33 and West-Fork-34, in particular, had high cover of bluebunch wheatgrass in 1999, corresponding with lower cheatgrass cover than the other aerial-seeded transects in this group (Fig. 16b; Tables 12-13).

At the Little-Sage-30 chained transect, located in the vicinity of the aerial-seeded transects just mentioned, seeded grass cover was low in 1999 relative to most other chained transects (Fig. 15a; Table 11). The recorded data for this transect show a decrease of both seeded grass and exotic grass cover between 1997 and 1999, while native grasses, dominated by needle-and-thread,

increased (Fig. 15a, 16a; Tables 11, 13). In another setting, the chained Eightmile-9 transect several miles south of the Leamington complex, both seeded grasses and bluebunch wheatgrass increased between 1997 and 1999, and cheatgrass was a minor component (Fig. 15a, 16a; Tables 11-13). The Eightmile-9 transect was located at 6050 ft.' elevation on south-facing, 8-14% slopes which had a high density of dead juniper, dead pinyon (Table 9) and live resprouting Gambel oak (Table 12). These examples demonstrate the capacity of native perennial grasses to take hold on favorable sites where they likely had a significant presence prior to the fires.

Flowell and Twin Complex

These fires were located farther south than the others, and included areas with a substrate of basalt rock. The Flowell-10 transect represented a small fire in the Black Rock Desert, at 4980 ft. elevation where normal precipitation is described as 8-10 inches per year (USDA-NRCS 1999). Despite chaining and high seeding rates (including 8.7 lbs/acre of Hycrest crested wheatgrass), seeded plant establishment at this site was poor, possibly because of low precipitation, soil factors, and/or grasshopper infestations such as one noted in 1999. This site had little rock at the surface and may have been suitable for drilling, but whether results would have been different with drilling here is unknown. No seeded grasses were recorded at this site in 1997, but by 1999 there was about 3% cover of mostly crested wheatgrass (Fig. 15a, 16a; Tables 11-12). Exotic grass cover was also relatively low both years (Fig. 15a; Tables 11-12), and the dominant plants at this site were tumblemustard and Russian thistle (Table 13). Halogeton (not shown in Table 13) was also present both years.

The Twin complex was located in a higher precipitation zone than Flowell, and rehabilitation treatments were more successful there. The five Twin drillings (Twin-1, -11, -12, -40, and -45) had good establishment of seeded plants, especially intermediate wheatgrass (including pubescent wheatgrass) which had been seeded at twice the rate of crested wheatgrass (Fig. 16c; Tables 11-12). Of forbs that had been seeded in the Twin drillings, alfalfa and small burnet persisted to 1999 (Fig. 16c; Tables 12-13), but yellow sweetclover did not. Small amounts of smooth brome, Russian wildrye, and forage kochia were also found growing at these sites, although they had not been reportedly seeded (Fig. 16c; Tables 12-13). Cheatgrass was very low at all the Twin drilled transects both years, dropping to one percent or less mean cover by 1999 (Fig. 15c, 16c; Tables 11-12). Three non-drilled, non-seeded transects (Twin-13, -42, and -46), each paired with a drilled transect, demonstrated that without drilling and perennial plant establishment, cheatgrass proliferation was still possible at these sites (Fig. 15b, 16b; Tables 15-16). At the non-seeded transect Twin-42, located in the Baker Canyon area on the north side of the Twin complex, western wheatgrass partially compensated for lack of seeded grasses (Fig.

16b). The adjacent drilled transect Twin-40 also had western wheatgrass, although its cover (i.e., native grass cover) apparently declined between 1997 and 1999 (Fig. 15c, 16c; Tables 11, 13). Seeded grass cover at Twin-40 was the highest of the Twin drilled transects (Fig. 15c, 16c; Tables 11-12), perhaps because of soil characteristics such as low percent surface rock (Table 9).

Two aerial-seeded transects (Baker-Canyon/North-Horse-39 and -43) on the north side of the Twin complex had been seeded with higher rates of intermediate/pubescent wheatgrass (7 lbs/acre) and alfalfa (2.3 lbs/acre), and lower rates of crested wheatgrass (1.4 lbs/acre) than aerial seedings elsewhere. Establishment and persistence of alfalfa were low at these transects (Fig. 16b; Table 12). Seeded grass establishment varied between these two transects: Baker-Canyon/North-Horse-43 had higher seeded grass cover, dominated by intermediate wheatgrass, while Baker-Canyon/North-Horse-37 had lower seeded grass cover, equally crested and intermediate (Fig. 15b, 16b; Tables 11-12). Although -43 was at a lower elevation (5690 ft. vs. 6150 ft. for -39), aerial seeding may have worked better here because of the greater slope (8-10% vs. 2% for -39) and rockiness (Table 9). Both -39 and -43 occurred in areas with moderate density of dead juniper (Table 9) and relatively high native grass cover (mostly bluebunch wheatgrass at -43; bottlebrush squirreltail, Indian ricegrass, and bluebunch wheatgrass at -39; Fig. 16b; Table 13).

Six chained transects (East-Horse-35, Center-Horse-36, South-Horse-38 and -44, and West-Horse-37 and -47), representing four seedings, were located in the Twin complex area. In general, cover and density of seeded grasses were slightly lower at these chained transects than at the Twin drilled transects (Fig. 15a, 15c; Tables 11, 14). Cover of native grasses and cheatgrass were also generally higher at these chained transects than at the Twin drilled transects (Fig. 15a, 15c, Table 11). These differences between chained and drilled transects may be due to site differences as well as treatment effects. South-Horse-38, located on the north side of the Twin complex, had the highest cover of native grasses (slender, bluebunch, and western wheatgrasses) and lowest cover of cheatgrass of these chained transects (Fig. 15a, 16a; Tables 11-13). West-Horse-47, in the central part of the complex, also had high cover of slender wheatgrass, and high cheatgrass cover as well (Fig. 16a; Table 13). These transects (South-Horse-38 and West-Horse-47), which had high cover of slender wheatgrass, had lower cover of intermediate wheatgrass than other chained transects in the Twin peaks complex (Fig. 12; Tables 13-E5). Note, however, that intermediate wheatgrass was inadvertently recorded in the small plots but not the large plots of South-Horse-38 (Table 12). These data suggest either that some intermediate wheatgrass was misidentified as slender wheatgrass, or that the presence of high amounts of residual slender wheatgrass at these sites inhibited establishment of intermediate wheatgrass. At West-Horse-37--which was higher, steeper, and rockier than West-Horse-47 (Tables 9, 11), and had very little

native grass (Table 11)--intermediate wheatgrass establishment was high, while crested wheatgrass establishment was low (Fig. 16a, Table 12). Crested wheatgrass and intermediate wheatgrass became established in near-equal proportions at East-Horse-35 and Center-Horse-36 (Fig. 16a, Table 12), both of which occurred on gentle (2-5%) slopes above 6000 ft. (Table 9).

Statistical Analyses of Extensive Study

In the previous section, we described vegetation responses to fire rehabilitation at the local level for the Extensive study, and offered hypotheses to explain some of these responses. Some of these hypotheses will be revisited as we consider the overall implications of the study in statistical terms.

Analyses of Variance

Analysis of variance results are shown in Figure 17 (two pages). These results should be interpreted in light of the fact that they do not represent a carefully controlled experiment with proper replication. Chained, aerial-seeded, and drilled treatments were not always present at the same site, thus treatment and site are often confounded. Variation between years may be partly due to differences in data collection by different observers in 1997 and 1999. The tests were further weakened by their failure to meet the assumption of normality, which we checked through the Shapiro-Wilk statistic (Shapiro and Wilk 1965) using the PROC UNIVARIATE procedure in SAS.

Despite these deficiencies in statistical rigor, several main effects were highly significant. Between 1997 and 1999 there were significant increases ($p<0.001$) in cover of vascular plants, seeded grasses and exotic grasses (Fig. 17). This is consistent with the expected reestablishment of grasses during the post-fire period. Forb cover, however, had a significant decrease ($p<0.001$) between 1997 and 1999 (Fig. 17b) that probably reflects the decline of annual forbs such as *Gilia* and *Descurainia* as well as the seeded forbs alfalfa and yellow sweetclover. The drilled treatment had significantly higher cover of vascular plants and forbs than the chained and aerial-seeded treatments ($p<0.01$; Fig. 17a-b), while seeded grass cover was higher in both chained and drilled than in aerial-seeded ($p<0.001$; Fig. 17c). Exotic grass cover was not significantly different between treatments at alpha=0.05, although the interaction between treatment and year was (Fig. 17d). The interaction between treatment and year was not significant at alpha=0.05 for forbs and seeded grasses. Note that results for native grass cover are not shown because an excess of zero values prevented SAS from completing the test.

CART (Classification and Regression Trees)

The diagrams shown in Figure 18 are classification trees generated by CART. These trees are the product of a procedure that splits datasets into progressively smaller groups using the predictor variables provided. The CART procedure we used is non-parametric and based on the median. The resubstitution relative error (RRE) given for each tree in Figure 18 indicates the strength of the relationship of variables in the tree. The RRE is similar to the coefficient of determination (R^2) of standard regression, except that larger RRE values indicate poorer relationships (i.e., 1-RRE is the equivalent of R^2). The RRE values shown in Figure 18 range from 0.53 to 0.78, indicating moderate to low strength of these relationships.

Each node of the CART trees shown in Figure 18 represents a set of the data for the given response variable, with Node 1 representing the full dataset and the other nodes representing smaller subsets. Shown for each node is the number of observations (N; equivalent to the number of 100 m^2 plots represented), the median of these observations (Med), and the mean absolute deviation (MAD), which is analogous to a standard deviation. Non-terminal nodes also show the predictor variable that was used to split the node, and the criteria for the split. Data that fit the criteria as defined in a particular mother node appear in the daughter node on the left-hand side. Terminal nodes appear where the CART procedure was unable to find an additional split, or where the minimum node size was reached. Our CART analysis was programmed so that no fewer than 10 observations could be used to make a node.

As an example to explain the interpretation of a classification tree, we use the tree for 1999 percent cover of crested wheatgrass shown in Figure 18a. Node 1 in Figure 18a shows statistics prior to any splitting of the data: 191 observations, a median of 3.0 and a mean absolute deviation of 10.9. The predictor variable that CART used to split Node 1 was elevation. The 104 plots with elevation less than or equal to 5775 ft. are split into one group, the daughter node to the left (Node 2), while the 87 plots with elevation greater than 5775 ft. appear in the daughter node to the right (Node 5). In this case, the daughter node on the right has a higher median (15.5) than the daughter node on the left (3.0), indicating that on average the cover of crested wheatgrass was higher above 5775 ft. than below (note that cover values in this example correspond to midpoints of cover classes). Node 2 (plots lower than or equal to 5775 ft.) was further split based on the seeding rate for crested wheatgrass, and showed a higher median value when this seeding rate was greater than 4.1 lbs/acre. Node 5 (plots higher than 5775 ft. elevation) was split based on treatment, a categorical variable. Treatments 1 (chained) and 2 (drilled) were grouped together and had a higher median value than Treatment 3 (aerial-seeded). Further splitting of nodes as shown in Figure 18a allows for interpretations such as the following: At elevations greater than 5775 ft. in aerial-seeded treatments where tree canopy cover was greater

than 9%, the median value for crested wheatgrass cover in 1999 was 15.5%. Another example: At elevations less than or equal to 5775 ft., where crested wheatgrass had been seeded at a rate higher than 4.1 lbs/acre, where litter cover was less than or equal to 14% in 1997, and where slope was less than or equal to 3.5%, the median value for crested wheatgrass cover in 1999 was 38%.

In the following sections, we make reference to the classification trees and discuss some of their more meaningful results. We base most of our discussion on results near the bases of the trees (tops of diagrams), since the outer branches of highly-branched trees are not easy to interpret and have lower statistical certainty.

Seeded Grasses

Classification trees for seeded grass cover in 1997 and 1999 are shown in Figures 18c-d. Trees are also shown for 1999 cover of the two principal seeded grass species, crested wheatgrass and intermediate wheatgrass (Fig. 18a-b). These trees indicate that controllable factors of the seeding process, such as treatment type, seeding rate, and timing of seeding, were not necessarily the most important determinants of seeding success. In the previous section we used the crested wheatgrass tree as an example of tree interpretation, and noted that elevation was the first predictor of crested wheatgrass cover (Fig. 18a). Elevation also appeared as the first predictor variable for total seeded grass cover, for both 1997 and 1999 (Fig. 18c-d). In each of these cases, the cover response was higher above the critical elevation, which ranged from 5275 ft. to 5815 ft (Fig. 18a, 18c-d). This pattern is intuitively reasonable since elevation tends to be correlated with precipitation and establishment of seeded plants is favored by precipitation.

The classification trees for seeded grass and crested wheatgrass also resembled each other in that, above the critical elevation, cover was higher in the chained and drilled treatments than the aerial-seeded treatment (Fig. 18a, 18c-d). This result agrees with the assumption that establishment is higher with treatments that include tillage and seed coverage. However, site factors might also explain this result, because different types of sites were chosen for chaining, drilling, and aerial seeding treatment. The classification trees also show that where tree canopy cover was higher (above 9-17%) in the aerial-seeded treatment above the critical elevation, cover of seeded grass and crested wheatgrass was also higher (Fig. 18a, 18c-d). This agrees with our observations in non-chained aerial seedings, where seeded grass establishment appeared to be concentrated in the zone beneath burned tree canopies (Ott 2001).

The classification trees for seeded grass cover show 1997 litter cover as an important predictor variable at lower elevations. We used litter cover from 1997 to approximate litter cover immediately following the fire. Below the critical elevation, in both 1997 and 1999, seeded grass

cover was higher where 1997 litter cover was lower than 16-18% (Fig. 18c-d). Litter appeared as a predictor variable at various other nodes of the classification trees for seeded grass, crested wheatgrass, and intermediate wheatgrass (Fig. 18a-d). In each of these cases, cover of the grass was higher where litter was lower. For intermediate wheatgrass, cover was lower where 1997 litter cover had exceeded 8.5%, except where higher seeding rates (greater than 3.9 lbs./acre) appeared to compensate (Fig. 18b). These patterns suggest an inhibitory effect of litter on seeded grass establishment, though the effect may not have been directly related to the litter itself. High litter cover following a fire may indicate low fire intensity, which would mean greater survival of residual plants and seeds that could compete with the seeded grasses. The effect of litter on seeded plant cover may in fact be a reflection of the effects of cheatgrass competition. Cheatgrass is discussed further in the following section.

Exotic Grasses

Figures 18e-f show classification trees for 1997 and 1999 exotic annual grass cover, as estimated using direct percentages. A similar tree is shown for 1999 cover of cheatgrass (the principal exotic grass species), as estimated using cover classes (Fig. 18g)[2]. These trees differ in their particulars but show some similar overall patterns. Elevation was the top predictor variable in each case, but unlike seeded grasses, exotic grass cover was *lower* above a critical elevation (5255-5315 ft. according to Fig. 18e-g; 5815 ft. according to Fig. 18g). Cheatgrass is apparently better adapted or more competitive at the lower end of the elevational range considered by this study. Below the critical elevation, the next most important predictor variable was 1997 litter cover, and again the pattern was opposite that of seeded grasses: exotic grass cover was *higher* above a critical litter cover value of 17-23% (Fig. Fig. 18e-g). The presence of litter may be a sign that viable cheatgrass seed is present. Furthermore, a surface with litter is more suitable for cheatgrass germination than a bare soil surface (Young et al. 1976).

As for what variables influence cheatgrass when litter cover is low, the 1999 exotic grass tree and 1999 cheatgrass tree gave different results. At lower elevations where litter cover did not exceed the critical value, cheatgrass cover was higher on steeper slopes (according to Fig. 18f) or on south-facing aspects (i.e., a broad arc that excluded north-, northeast-, and northwest-facing aspects; Fig. 18g). The competitive advantage of cheatgrass on warmer, south-facing aspects in Eastern Utah was discussed by Goodrich and Huber (1999).

[2]Figure 18g (1999 cheatgrass cover) is the only CART tree shown with eight classes for the aspect variable. All other trees shown in Figure 18 were computed with the aspect variable having two classes (i.e., north-facing and south-facing).

The classification trees for 1997 and 1999 exotic grass cover have numerous branches dividing the portion of the data above the critical elevation (Fig. 18e-f). Elevation reappeared as a predictor variable in various places, and in most but not all cases exotic grass cover was lower at the lower elevation. Percent rock (>1 cm diameter), as measured in 1997, also appeared as a predictor variable, and in three of the four nodes where it occurred, exotic grass cover was higher with higher percent rock. Another repeated pattern was higher exotic grass cover at *lower* levels of pinyon density, juniper density, and tree canopy cover (Fig. 18e-f). This latter relationship could be the result of lower pre-burn cheatgrass abundances at sites with high numbers of trees, or of the reduction of cheatgrass seed densities through higher-intensity fires at these sites. In 1997, pinyon density was the most important variable found to predict exotic grass cover at elevations above 5315 ft (Fig. 18e). In 1999, however, treatment was the most important predictor variable, and chained and drilled treatments had lower cover than aerial-seeded treatments (Fig. 18f). Treatment type thus appeared to be unimportant initially in its effect on exotic grass cover, but by three years after the fire, the different effects of these earlier treatments had become evident.

Native Grasses

The CART procedure was able to generate a classification tree for native grass cover only for 1997 (Fig. 18h). The primary predictor variable for this tree was juniper density, and native grass cover was higher where juniper density was greater than 68 per acre. Elevation was the next predictor variable on both branches of the tree, but its effect was different in each case: below the critical juniper density, native grass cover was higher at *higher* elevations (above 5750 ft.), while above the critical juniper density, native grass cover was higher at *lower* elevations (at or below 5775 ft.). Slope was a predictor variable at the next level of these branches with higher cover, but it likewise did not have a consistent effect: below the critical juniper density, native grass cover was higher on *steeper* slopes (above 2.5%), while above the critical juniper density, native grass cover was higher on *less steep* slopes (at or below 6.5%). These patterns may reflect the different habitat affinities of different native grass species, e.g. western wheatgrass in flat areas vs. bluebunch wheatgrass on slopes. Interpretation of Figure 18h is complicated by the inclusion of several ecologically different species under the label "native grass." Also, some of the relatively small differences in native grass cover that were split apart by the CART procedure may not be biologically significant.

Total Vascular Plant Cover

The classification trees for total vascular plant cover in 1997 and 1999 (Fig. 18i-j) represent the net response of seeded, native, and exotic grass categories, plus forbs and shrubs. Elements of the trees discussed previously can be seen in the vascular plant cover trees, e.g. elevation as the primary predictive variable. Lower elevations (below 5255-5295 ft.) actually had higher vascular plant cover on average than higher elevations, although this is probably largely due to a greater cover of cheatgrass. Above the critical elevation, the aerial-seeded treatment showed higher vascular plant cover than the chained and drilled treatment in 1999 (Fig. 18j), despite having lower cover of seeded grasses (Fig. 18d).

CONCLUSIONS AND RECOMMENDATIONS

The studies presented in this report document the effects of the 1996 wildfires and BLM rehabilitation treatments on vegetation across the study area in Juab and Millard counties, Utah. The data presented in this report show the first- to third-year vegetation responses at each study site and across the entire study area. This information may be useful for future management and rehabilitation of these and similar sites, although it must be remembered that under different circumstances (e.g., climatic events), vegetation responses may be different. We expect that the information in this report will be used by managers in conjunction with other sources of information and personal experience.

Most of the sites sampled in these studies were in the sagebrush and pinyon-juniper zones between ca. 5000 ft. and 6550 ft. elevation (although the Tanner Creek site was lower, near 4200 ft.). The fires removed most woody vegetation at these sites and allowed for the proliferation of cheatgrass at many sites, especially where competition from perennials was low. Seeded perennials generally had higher establishment in drilled and chained treatments than in aerial-seeded treatments, although there was considerable variation among sites. Differences in elevation, soils, topography, pre-burn vegetation, fire intensity and post-fire management were proposed as reasons for different site responses.

Classification and regression tree (CART) analysis showed elevation as the foremost predictor of seeded grass and cheatgrass cover responses, regardless of treatment type. Elevation effects are probably mostly a reflection of precipitation effects. Below a critical elevation of ca. 5275-5815 ft., seeded grass cover was low (1999 median=4.5%) and cheatgrass cover high (1999 median=15.5%), while above this elevation, seeded grass cover was high (1999 median=15%) and cheatgrass cover low (1999 median=3%). Above this critical elevation, chained and drilled

treatments had higher seeded grass cover than aerial-seeded treatments, although aerially seeded sites with high canopy cover of dead trees also had high seeded grass cover. The critical elevation is approximate because of variation between tree diagrams and also because GPS-derived elevation measurements were probably somewhat inaccurate. Nevertheless, these results suggest that lower-elevation areas may require greater attention and intensity of treatment in rehabilitation efforts, probably mostly because of lower available moisture. CART analysis showed that below the critical elevation, cover of crested wheatgrass was higher (1999 median=15.5% vs. 3%) where crested wheatgrass seeding rates were higher than 4 lbs/acre. This figure combines the seeding rates of 'Hycrest' and 'Nordan' crested wheatgrass, although 'Hycrest' was more widely used. Plant materials known to establish under drier conditions and compete with cheatgrass are recommended for lower elevation sites.

The amount of litter present one year after the fire also proved useful in predicting seeded grass and cheatgrass cover responses using CART. Below the critical elevation of 5275-5815 ft., seeded grass cover was lower and cheatgrass cover higher where litter cover exceeded 16-23% one year following the fire. Of the seeded grasses, intermediate wheatgrass was particularly affected by litter, having lower cover where post-fire litter exceeded 8.5%. The reason for these effects is not entirely clear, but we suspect that it may be related to fire intensity, i.e. lower intensity fires result not only in greater residual litter but also greater survival of seeds of cheatgrass and other plants that could compete with seeded plants. Extra attention may need to be given to sites where residual litter cover is high and/or fire intensity was low, provided that these parameters can be assessed prior to rehabilitation. On the other hand, if residual native perennials are abundant at a site, the need for rehabilitation may be less.

We realize that other factors besides those considered in this report could have influenced the results that we have presented and interpreted. We encourage additional data interpretation as well as continued monitoring of study plots so that the long-term effects of the rehabilitation treatments may be better understood.

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Table 1. Description of Intensive Study sites: treatments, location, elevation, slope, soils

Site Name	Treatments	Location (marker)	Elevation	Slope	Soils
Cunningham (East transects)	Chained Non-chained Old Seeding	Section marker T26S R7W S34 S35 T27S S2	6220-6300'	2-10%	Clegg cobbly loam[a]
Cunningham (West transects)	Intact Seeded Slopes	Canyon mouth north of Woodtick Hill, T27S R7W S34 S35 S2 T27S	6400-6500'	20-35%	Red Butte very rocky loam[a]
Dog Slopes	Chained Non-chained	110m at 195° from Tidwell Spring exclosure, T13S R2W S19	5420-5560'	20-34%	Saxby very cobbly loam[b]
Gilson	Chained Non-chained Non-seeded Old Seeding Intact	Section marker T13S R3W S35 T14S R3W S1 S2	5320-5400'	4-15%	Borvant cobbly loam[b]
Jericho	Chained Non-chained Non-seeded Drilled Intact	Milemarker 124, US Highway 6, T12S R3W S28	5420-5480'	4-16%	Jericho gravelly fine sandy loam[b]
Paul Bunyan	Chained Non-chained	Near Paul Bunyan's Woodpile road, T12S R3W S23	5900-5940'	5-11%	Jericho gravelly fine sandy loam[b]
Railroad	Chained Non-chained	151m at 195° from section marker T12S R3W S15 S16 S21 S22	5480-5520'	5-7%	Wales loam[b]
Twin	Chained Non-chained Non-seeded Drilled Intact	Quarter-section marker T25S R7W S29 S32	5900-5940'	1-6%	Kessler-Penoyer very cobbly loam[a]

a. Stott, L.H., and M.E. Olsen. 1976. Soil survey of Beaver-Cove Fort area, Utah. USDA Soil Conservation Service.
b. Trickler, D.L. and D.T. Hall. 1984. Soil survey of Fairfield-Nephi area. USDA Soil Conservation Service.

Table 2: Definition of Intensive Study Treatments

Treatment Label	Burned	Chained	Aerially Seeded	Drilled
Chained	**Yes**	**Yes**	**Yes**	No
Drilled	**Yes**	No	No	**Yes**
Intact	No	No	No	No
Non-chained	**Yes**	No	**Yes**[1]	No
Non-seeded	**Yes**	No	No	No
Old Seeding	**Yes**	**Yes**[2]	**Yes**[2]	No[2]
Seeded Slopes[3]	**Yes**	No	**Yes**	No

[1] At the Cunningham study site, seeding was irregular on the "non-chained" treatment
[2] "Old Seeding" treatments had been seeded prior to the fire. At the Cunningham site, the "old seeding" treatment was re-seeded and re-chained. The Gilson site "old seeding" had been drilled prior to the 1996 fire, and received no new treatment following the fire.
[3] "Seeded Slopes" treatment (Cunningham site only) was aerially-seeded like the non-chained treatment, but is treated separately because it occurred on rocky sloping terrain where chaining would not have been feasible.

Table 3a. Mean percent cover of categories by treatment, site and year; tree density, and data collection dates (Intensive Study sites: chained and non-chained treatments)

Site	Year	Bare Soil[1]	Litter[1]	Rock >1cm[1]	Cryptogams[1]	Vascular Plants[1]	Shrubs &Trees[2]	Forbs[2]	Exotic Grass[2]	Native Grass[2]	Seeded Grass[2]	Tree Canopy[3]	Tree No./ha[4]	Date of Data Collection
Chained Treatment														
Cunningham	1997	44 (51)	11 (14)	28 (24)	+	18 (14)	2	6	3	2	4	15		Jul11,16,28
Cunningham	1998	17 (35)	7 (6)	9 (11)	0	68 (49)	7	12	24	2	22	13	2438	Jun30
Cunningham	1999	34 (41)	21 (24)	13 (14)	0	33 (22)	7	1	14	1	9	14		Aug04,05
Dog Slopes	1997	36 (41)	15 (13)	20 (23)	0	29 (24)	+	3	3	11	12	16		Aug20
Dog Slopes	1998	22 (31)	10 (7)	12 (16)	0	56 (46)	+	3	6	24	23	15	1625	Jun24
Dog Slopes	1999	14 (18)	14 (13)	11 (14)	0	63 (55)	1	1	7	23	31	18		Jul21
Gilson	1997	36 (43)	20 (13)	4 (4)	+	40 (41)	+	6	6	18	10	25		Aug21
Gilson	1998	17 (27)	11 (12)	1 (2)	0	71 (60)	+	6	18	25	23	25	563	Jun25
Gilson	1999	17 (14)	16 (17)	1 (1)	0	66 (69)	+	2	22	20	22	26		Jul12,20
Jericho	1997	46 (68)	8 (4)	10 (7)	+ (1)	36 (21)	+	5	16	3	12	9		Aug25,26
Jericho	1998	22 (47)	7 (3)	4 (4)	+ (+)	68 (46)	+	8	21	4	34	9	438	Jun15
Jericho	1999	23 (43)	14 (14)	5 (4)	+ (+)	58 (39)	1	2	18	4	32	8		Jun22,23
Paul Bunyan	1997	58 (51)	10 (14)	14 (18)	0	19 (18)	2	6	1	2	9	7		Aug11
Paul Bunyan	1998	36 (40)	10 (16)	9 (11)	0	46 (33)	3	6	12	4	21	8	2625	Jun22
Paul Bunyan	1999	33 (34)	14 (21)	8 (10)	0	46 (35)	3	2	17	4	21	10		Jul28
Railroad	1997	28 (54)	8 (11)	1 (1)	+	64 (35)	1	5	38	5	15	0		Aug28
Railroad	1998	17 (24)	3 (5)	1 (1)	+ (+)	80 (71)	1	4	37	6	33	0	125	Jun19,22
Railroad	1999	13 (15)	19 (21)	+ (+)	+ (+)	69 (64)	2	1	25	3	38	0		Jun30
Twin	1997	39 (55)	4 (4)	18 (16)	0	40 (25)	+	5	12	2	21	0		Aug01
Twin	1998	19 (37)	2 (3)	10 (9)	0	69 (51)	+	3	11	3	52	0	0	Jun30
Twin	1999	23 (35)	15 (8)	11 (9)	0	53 (49)	+	1	5	1	45	0		Jul14,15
Non-chained Treatment														
Cunningham	1997	54 (61)	16 (8)	11 (18)	0	19 (13)	+	8	8	2	+	31		Jul03,08
Cunningham	1998	21 (23)	3 (4)	5 (4)	0	71 (69)	2	22	43	2	2	36	2125	Jul01
Cunningham	1999	21 (26)	35 (32)	6 (5)	0	39 (38)	2	1	34	1	1	38		Aug05
Dog Slopes	1997	40 (33)	14 (10)	29 (43)	0	18 (15)	+	6	1	8	2	19		Aug19
Dog Slopes	1998	12 (30)	5 (9)	23 (23)	+ (1)	60 (38)	+	9	8	35	8	15	2063	Jun23
Dog Slopes	1999	14 (17)	8 (8)	19 (23)	1 (1)	59 (51)	1	5	10	34	9	18		Jul20,21
Gilson	1997	48 (50)	6 (5)	9 (14)	+ (+)	38 (31)	+	21	9	5	2	30		Aug21,22
Gilson	1998	21 (35)	8 (10)	7 (12)	0	65 (44)	+	21	34	5	5	28	1375	Jun25
Gilson	1999	14 (23)	15 (13)	4 (12)	+ (+)	68 (53)	+	6	43	7	12	29		Jul09
Jericho	1997	28 (54)	9 (8)	14 (10)	2 (1)	49 (28)	+	11	33	3	2	18		Aug25,27
Jericho	1998	12 (12)	6 (4)	4 (3)	+ (1)	79 (80)	0	9	65	3	2	12	875	Jun11,15,19
Jericho	1999	12 (8)	12 (25)	2 (4)	0 (1)	74 (64)	+	8	59	4	3	11		Jun22,28
Paul Bunyan	1997	55 (51)	6 (8)	16 (14)	0	23 (28)	+	13	4	4	1	20		Aug11
Paul Bunyan	1998	38 (31)	6 (10)	12 (18)	0	44 (41)	+	6	24	9	4	20	2000	Jun22
Paul Bunyan	1999	22 (21)	14 (24)	11 (11)	0	54 (45)	1	4	32	11	7	29		Jul30,Aug02
Railroad	1997	22 (24)	9 (9)	+	1	69 (68)	+	3	61	3	2	+		Aug28
Railroad	1998	6 (9)	2 (4)	1	+ (+)	92 (87)	+	3	82	3	4	0	63	Jun22
Railroad	1999	46 (36)	29 (35)	1 (1)	+	25 (29)	0	6	11	3	5	0		Jul06/07
Twin	1997	29 (33)	6 (13)	16 (19)	1 (1)	49 (36)	1	6	27	13	2	+		Aug01
Twin	1998	5 (10)	2 (3)	6 (10)	+	88 (78)	1	5	62	14	6	+	0	Jun30
Twin	1999	6 (8)	28 (29)	9 (12)	0	58 (51)	1	4	35	14	4	0		Jul16

[1] cover value on left is mean percent cover of $100m^2$ plots; value in parentheses is mean percent cover of $1m^2$ plots, if greater than zero
[2] cover value is mean percent cover of $100m^2$ plots; estimates for $1m^2$ plots were not made for these categories
[3] mean percent canopy cover for $100m^2$ plots, of dead trees as if foliated, whether trees in standing of fallen (i.e., chained) position
[4] density of trees (juniper and pinyon) based on post-fire (1998) counts of dead trees, in four 4m x 40m transects per treatment

Table 3b. Mean percent cover of categories by treatment, site and year; tree density, and data collection dates (Intensive Study sites: drilled, aerial-seeded slopes, non-seeded, old seedings, and intact treatments)

Site	Year	Bare Soil[1]	Litter[1]	Rock >1cm[1]	Crypto-gams[1]	Vascular Plants[1]	Shrubs &Trees[2]	Forbs[2]	Exotic Grass[2]	Native Grass[2]	Seeded Grass[2]	Tree Canopy[3]	Tree No./ha[4]	Date of Data Collection
Drilled Treatment														
Jericho	1997	36 (40)	3 (3)	5 (5)	0	56 (53)	+	16	20	8	14	0		Aug27
Jericho	1998	29 (32)	3 (6)	3 (3)	0	65 (60)	+	10	8	6	41	0	0	Jun19
Jericho	1999	23 (27)	11 (13)	2 (2)	0	65 (59)	+	1	7	10	48	0		Jun25,28
Twin	1997	36 (48)	2 (2)	5 (4)	0	58 (48)	+	24	1	1	31	0		Aug01,14
Twin	1998	14 (20)	3 (4)	3 (2)	0	81 (74)	0	41	+	1	40	0	0	Jun30
Twin	1999	41 (28)	14 (13)	5 (4)	0	41 (44)	0	8	+	+	33	0		Jul15
Aerial-seeded Slopes														
Cunningham	1997	29 (26)	5 (10)	31 (41)	+	35 (23)	1	5	17	5	7	40		Jul22,28
Cunningham	1998	5 (8)	3 (3)	14 (19)	+	78 (71)	+	5	27	1	44	44	2563	Jul01
Cunningham	1999	7 (8)	22 (19)	16 (31)	0	55 (43)	1	1	23	1	30	49		Aug12
Non-seeded Treatment														
Gilson	1997	35 (40)	8 (10)	10 (14)	+ (+)	48 (36)	+	21	21	6	+	38		Aug21
Gilson	1998	18 (22)	5 (6)	3 (4)	+	75 (69)	+	14	54	7	+	34	1625	Jun24
Gilson	1999	7 (8)	18 (25)	3 (2)	+	73 (66)	1	5	60	5	+	36		Jul08
Jericho	1997	44 (36)	8 (5)	10 (4)	+	39 (55)	+	1	35	2	+	9		Aug26,27
Jericho	1998	12 (13)	2 (2)	2 (1)	+	85 (85)	+	4	74	5	2	9	313	Jun16
Jericho	1999	9 (10)	18 (16)	2 (1)	+	73 (74)	+	15	51	2	2	8		Jun23,25
Twin	1997	30 (34)	5 (6)	20 (38)	+ (+)	45 (23)	+	7	33	5	0	1		Jul31,Aug01
Twin	1998	6 (3)	2 (3)	2 (4)	0	91 (90)	1	4	80	7	0	1	188	Jun29,30
Twin	1999	6 (3)	34 (49)	7 (10)	0	54 (39)	1	5	42	5	0	1		Jul14
Old Seeding Treatment														
Cunningham	1997	35 (54)	10 (5)	10 (11)	0	45 (30)	2	8	8	1	26	4		Jul10,15
Cunningham	1998	25 (25)	6 (7)	3 (6)	0	66 (61)	3	10	4	14	35	6	125	Jul06
Cunningham	1999	39 (38)	31 (33)	7 (6)	0	23 (24)	2	2	1	+	18	6		Aug05
Gilson	1997	29 (50)	9 (11)	3 (1)	1 (+)	59 (39)	0	4	2	17	36	+		Aug22
Gilson	1998	21 (31)	18 (18)	1 (1)	3 (4)	58 (48)	0	1	7	13	37	+	0	Jun25
Gilson	1999	28 (34)	18 (17)	1 (1	5 (6)	49 (43)	0	1	3	5	39	+		Jul12
Intact (Unburned) Treatment														
Cunningham	1997	24 (30)	16 (21)	39 (40)	+ (2)	21 (8)	5	3	9	4	0	21		Jul22
Cunningham	1998	25 (29)	16 (16)	38 (45)	1 (1)	21 (9)	5	3	8	6	0	30	3563	Jul06
Cunningham	1999	29 (31)	19 (18)	34 (43)	1 (1)	19 (8)	3	3	6	7	0	29		Aug06,13
Gilson	1997	19 (38)	19 (24)	10 (11)	9 (9)	44 (19)	5	3	25	10	+	43		Aug20,21
Gilson	1998	24 (38)	14 (11)	8 (9)	9 (10)	46 (32)	3	6	28	9	+	36	1500	Jun24
Gilson	1999	21 (31)	20 (13)	8 (11)	14 (20)	38 (25)	5	3	24	5	+	35		Jul08,09
Jericho	1997	20 (24)	10 (24)	11 (20)	6 (8)	53 (12)	28	1	15	9	0	18		Aug22,25
Jericho	1998	30 (19)	8 (18)	10 (16)	5 (13)	48 (34)	19	1	17	10	0	18	688	Jun11
Jericho	1999	26 (33)	13 (17)	12 (18)	6 (21)	44 (23)	20	2	12	10	+	16		Jun22
Twin	1997	20 (16)	10 (15)	14 (11)	2 (2)	55 (56)	26	9	12	7	0	0		Jul29
Twin	1998	21 (16)	10 (10)	11 (10)	2 (6)	56 (60)	20	8	19	9	0	+	188	Jun29
Twin	1999	23 (17)	10 (15)	13 (10)	2 (8)	51 (51)	20	10	11	11	0	+		Aug11,13

[1] cover value on left is mean percent cover of $100m^2$ plots; value in parentheses is mean percent cover of $1m^2$ plots, if greater than zero
[2] cover value is mean percent cover of $100m^2$ plots; estimates for $1m^2$ plots were not made for these categories
[3] mean percent canopy cover for $100m^2$ plots, of dead trees as if foliated, whether trees in standing of fallen (i.e., chained) position
[4] density of trees (juniper and pinyon) based on post-fire (1998) counts of dead trees, in four 4m x 40m transects per treatment

Table 4a. Mean percent cover of important species by treatment, site and year; varieties and seeding rates (Intensive Study sites: chained and non-chained treatments)

		Crested Wheatgrass			Intermediate/Tall Wheatgrass			Smooth Brome		Russian/Basin Wildrye			Alfalfa		Yellow Sweetclover		Cheat-grass
Chained Treatment		Var[1]	Seed Rate[2]	Mean Cover[3]	Var[1]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Var[1]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Mean Cover[3]
Cunningham	1997	EFH	2.3	2 (4)	I	1.0	1	2.0	1 (3)	S	0.4	0	1.6	1 (+)	1.0	1 (+)	3 (1)
Cunningham	1998			2 (12)			2 (2)		6 (9)			+		2 (8)		2 (1)	24 (10)
Cunningham	1999			2 (6)			1 (1)		6 (5)			0		1 (1)		0	18 (4)
Dog Slopes	1997	EFH	4.9	6 (4)	PT	4.5	6 (8)	0.0	0	Z	2.1	0	0.0	0	0.0	0	1 (2)
Dog Slopes	1998			12 (11)			18 (21)		0			0		+		0	5 (3)
Dog Slopes	1999			15 (18)			18 (18)		0			+		0		0	5 (5)
Gilson	1997	H	3.0	2 (3)	T	2.0	6 (3)	2.0	2 (1)	Z	2.0	0	0.0	0	0.0	0	6 (8)
Gilson	1998			2 (5)			1 (10)		8 (6)			2 (1)		0		0	12 (11)
Gilson	1999			9 (11)			9 (18)		9 (10)			0		0		0	18 (25)
Jericho	1997	H	3.1	3 (5)	T	2.0	9 (3)	1.8	2 (2)	BZ	3.1	0	0.0	0	0.0	+	9 (10)
Jericho	1998			12 (10)			2 (1)		9 (4)			6 (1)		0		+	21 (24)
Jericho	1999			21 (17)			9 (6)		6 (6)			0		0		0	15 (15)
Paul Bunyan	1997	H	4.0	2 (4)	T	2.0	2 (5)	0.0	+	Z	3.0	0	0.0	0	0.0	+	2 (1)
Paul Bunyan	1998			9 (6)			2 (4)		1			5 (4)		0		+	11 (9)
Paul Bunyan	1999			9 (7)			5 (6)		+			2 (2)		0		0	20 (11)
Railroad	1997	H	3.1	3 (3)	T	2.0	9 (2)	1.8	2 (2)	BZ	3.1	1	0.0	0	0.0	0	29 (23)
Railroad	1998			6 (5)			3 (2)		9 (4)			6 (3)		0		0	51 (51)
Railroad	1999			9 (10)			16 (7)		9 (8)			2 (2)		0		0	21 (39)
Twin	1997	HN	8.5	6 (6)	P	2.9	3 (12)	0.0	0	Z	3.7	2	0.3	+	0.0	0	9 (3)
Twin	1998			9 (13)			32 (41)		0			2 (1)		1		0	9 (3)
Twin	1999			9 (21)			32 (28)		0			1 (1)		+		0	6
Non-chained Treatment																	
Cunningham	1997	EFH	2.3	+	I	1.0	0	2.0	+ (+)	S	0.4	+	1.6	+	1.0	+	6 (6)
Cunningham	1998			+			+		1 (3)			+		+		1	57 (44)
Cunningham	1999			+			+		+ (2)			0		0		0	38 (31)
Dog Slopes	1997	EFH	4.9	2 (1)	PT	4.5	1 (2)	0.0	0	Z	2.1	0	0.0	0	0.0	0	2 (1)
Dog Slopes	1998			2 (4)			2 (5)		0			+		0		0	6 (3)
Dog Slopes	1999			5 (5)			5 (8)		0			+		0		0	12 (4)
Gilson	1997	H	5.0	1 (1)	T	2.0	1	2.0	1 (2)	Z	2.0	0	0.0	0	0.0	0	9 (2)
Gilson	1998			1 (4)			+		2 (5)			+ (1)		0		0	33 (13)
Gilson	1999			4 (8)			2		6 (9)			+ (1)		0		0	51 (18)
Jericho[4]	1997	H	3.1-	1	T	2.0	+	0.0-	1	BZ	3.0-	0	0.0	0	0.0	0	33 (23)
Jericho	1998		4.0[4]	1 (+)			+ (3)	1.8[4]	1		3.1[4]	1 (1)		+		0	69 (69)
Jericho	1999			1 (+)			1 (6)		1			1 (1)		0		0	69 (54)
Paul Bunyan	1997	H	4.0	+ (4)	T	2.0	+ (1)	0.0	+ (1)	Z	3.0	0	0.0	0	0.0	0	3 (4)
Paul Bunyan	1998			1 (4)			+		+ (4)			1 (4)		0		0	27 (21)
Paul Bunyan	1999			5 (5)			2 (+)		1 (3)			1 (4)		0		0	33 (26)
Railroad	1997	H	3.1	1	T	2.0	+	1.8	1 (1)	BZ	3.1	+	0.0	0	0.0	0	57 (61)
Railroad	1998			1			1 (1)		2 (3)			+		0		0	85 (85)
Railroad[5]	1999	?[5]	?[5]	1 (2)	?[5]	?[5]	2 (4)	?[5]	2 (1)	?[5]	?[5]	+	?[5]	1	?[5]	0	16 (16)
Twin	1997	HN	8.5	1	P	2.9	+	0.0	0	Z	3.7	+	0.3	+	0.0	+	27 (19)
Twin	1998			2			2		0			+		+		0	68 (61)
Twin	1999			3 (1)			2		0			+		+		0	32 (31)

[1] varieties in seed mixes; E=Ephraim crested wheatgrass, H=Hycrest crested wheatgrass, N=Nordan crested wheatgrass, I=Intermediate wheatgrass, P=Pubescent wheatgrass, T=Tall wheatgrass, B=Basin wildrye, S=Swift Russian wildrye, Z=Bozoisky Russian wildrye

[2] seeding rate in lbs./acre, placed here with 1997 although many seed mixes were actually applied in 1996

[3] value on left is mean percent cover of 100m^2 plots; value in parentheses is mean percent cover of 1m^2 plots, if greater than zero

[4] Jericho non-chained included two seed mixes on opposite sides of U.S. Highway 6

[5] Railroad non-chained was reseeded with an unknown (to author) seed mix, followed by double-chaining, between 1998 and 1999

+ indicates mean values less than 0.5; other values are rounded to nearest whole number

Table 4b. Mean percent cover of important species by treatment, site and year; varieties and seeding rates (Intensive Study sites: drilled, aerial-seeded slopes, non-seeded, old seedings, and intact treatments)

		Crested Wheatgrass			Intermediate/Tall Wheatgrass			Smooth Brome		Russian/Basin Wildrye			Alfalfa		Yellow Sweetclover		Cheat-grass
		Var[1]	Seed Rate[2]	Mean Cover[3]	Var[1]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Var[1]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Mean Cover[3]
Drilled Treatment																	
Jericho	1997	H	4.1	16 (13)	I	2.1	16 (13)	0.0	0	Z	2.1	+	0.0	1 (1)	0.0	1	3 (6)
Jericho	1998			21 (18)			12 (15)		+ (1)			9 (8)		1 (2)		3 (2)	12 (10)
Jericho	1999			27 (28)			12 (24)		+ (1)			2 (1)		+ (1)		+	12 (8)
Twin	1997	H	2.2	16 (11)	IP	4.4	6 (20)	0.0	1 (1)		0.0	+ (1)	1.2	12 (7)	0.5	9 (8)	2 (1)
Twin	1998			16 (9)			21 (30)		1 (2)			1 (3)		12 (14)		27 (31)	0
Twin	1999			16 (25)			9 (15)		1 (+)			+		3 (5)		0	0
Aerial-Seeded Slopes																	
Cunningham	1997	EFH	2.3	2 (8)	I	1.0	1 (1)	2.0	3 (5)	S	0.4	0	1.6	1 (+)	1.0	1 (1)	12 (9)
Cunningham	1998			12 (20)			6 (2)		27 (28)			1 (2)		2 (3)		6	27 (24)
Cunningham	1999			12 (12)			3 (1)		16 (18)			1 (2)		0 (1)		0	27 (11)
Non-seeded Treatment																	
Gilson	1997		0.0	0		0.0	0	0.0	0		0.0	0	0.0	0	0.0	0	18 (13)
Gilson	1998			0			0		0			+		0		0	56 (56)
Gilson	1999			+ (+)			+		0			+		0		0	63 (64)
Jericho	1997		0.0	+		0.0	+	0.0	0		0.0	0	0.0	0	0.0	0	36 (54)
Jericho	1998			+			1		+			0		0		0	69 (83)
Jericho	1999			+			1		+			0		0		0	63 (66)
Twin	1997		0.0	0		0.0	0	0.0	0		0.0	0	0.0	0	0.0	0	32 (18)
Twin	1998			0			0		0			0		0		0	85 (89)
Twin	1999			0			0		0			0		0		0	38 (34)
Old Seeding Treatment																	
Cunningham	1997	EFH	2.3	6 (5)	I	1.0	6 (5)	2.0	9 (6)	S	0.4	+	1.6	1 (1)	1.0	+ (+)	6 (7)
Cunningham	1998			9 (16)			9 (9)		16 (24)			+		1 (2)		2 (2)	3 (3)
Cunningham	1999			9 (6)			2 (2)		9 (12)			+		+		0	3 (1)
Gilson	1997		0.0	38 (26)		0.0	0	0.0	0		0.0	0	0.0	0	0.0	0	2 (+)
Gilson	1998			38 (33)			0		0			0		0		0	6 (2)
Gilson	1999			38 (37)			0		0			0		0		0	5 (+)
Intact Treatment																	
Cunningham	1997		0.0	1		0.0	0	0.0	0		0.0	0	0.0	0	0.0	0	9 (1)
Cunningham	1998			0			0		0			0		0		0	9 (1)
Cunningham	1999			0			0		0			0		0		0	9 (1)
Gilson	1997		0.0	0		0.0	0	0.0	0		0.0	0	0.0	0	0.0	0	27 (7)
Gilson	1998			0			0		0			0		0		0	27 (17)
Gilson	1999			0			0		0			0		0		0	27 (12)
Jericho	1997		0.0	0		0.0	0	0.0	0		0.0	0	0.0	0	0.0	0	18 (6)
Jericho	1998			0			0		0			0		0		0	21 (8)
Jericho	1999			0			0		0			0		0		0	18 (3)
Twin	1997		0.0	0		0.0	0	0.0	0		0.0	0	0.0	0	0.0	0	12 (16)
Twin	1998			0			0		0			0		0		0	18 (26)
Twin	1999			0			0		0			0		0		0	6 (13)

[1] varieties in seed mixes; E=Ephraim crested wheatgrass, H=Hycrest crested wheatgrass, N=Nordan crested wheatgrass, I=Intermediate wheatgrass, P=Pubescent wheatgrass, T=Tall wheatgrass, B=Basin wildrye, S=Swift Russian wildrye, Z=Bozoisky Russian wildrye

[2] seeding rate in lbs./acre, placed here with 1997 although many seed mixes were actually applied in 1996

[3] value on left is mean percent cover of $100m^2$ plots; value in parentheses is mean percent cover of $1m^2$ plots, if greater than zero

+ indicates mean values less than 0.5; other values are rounded to nearest whole number

Table 5a. Mean percent cover (100m^2 plots) of miscellaneous important species by treatment, site and year (Intensive study sites: chained and non-chained treatments)

		Seeded			Native Grasses						Native Forbs and Shrubs									Exotic Forbs									
		Atriplex canescens	*Kochia prostrata*	*Sanguisorba minor*	*Agropyron smithii*	*Agropyron spicatum*	*Oryzopsis hymenoides*	*Poa* spp.	*Sitanion hystrix*	*Stipa comata*	*Artemisia tridentata*	*Astragalus* spp.	*Chrysothamnus* spp.	*Crepis* spp.	*Cryptantha* spp.	*Gutierrezia sarothrae*	*Phlox* spp.	*Sphaeralcea* spp.	*Vicia americana*	*Alyssum desertorum*	*Camelina microcarpa*	*Descurainia* spp.*	*Lactuca serriola*	*Onopordum acanthium*	*Ranunculus testiculatus*	*Salsola pestifer*	*Sisymbrium altissimum*	*Tragopogon dubius*	*Bromus tectorum*
Chained Treatment																													
Cunningham	1997		6	+		+	1	+	1		1	+		+	1		1	+		2		+	1			+		+	3
Cunningham	1998		6	1		1	1	+	1		1	+		+			1	+		2		+	1				+		24
Cunningham	1999	+	6	1		+	1		1		1	+						+		1			+						18
Dog Slopes	1997		+			12	1	+	+			+		+	+	1	1			+		1	2			+		+	1
Dog Slopes	1998					18	1	+		+		+		+	+	1	+			1	+	1	1				1		5
Dog Slopes	1999					17	1	1		+		+		+	+	1	+			1	+	+	+			+	+	+	5
Gilson	1997	+			20	1	+	1	+			+		+			1	1		1	1	1	1		+	+	+	+	6
Gilson	1998	+			29	1	+	2	1			+		+			1	1		+	1	1	2				2	+	12
Gilson	1999	+			26	1	+	+	+			+		+		+	+	1		1	1		+				1	+	18
Jericho	1997	+					4		1			+	+				+	1		+		+		+		+	1	+	9
Jericho	1998	+					5		1			+	+		+			1		+		+	+	+			9		21
Jericho	1999	1					4		+			+	+					+		+			+				2		15
Paul Bunyan	1997	4				2	+		+			+					1						+						2
Paul Bunyan	1998	4				2	1		+			+					1			+	+	1	5			+	+	+	11
Paul Bunyan	1999	4				2	1		+			+					+			+	+		2			+	1	+	20
Railroad	1997	1			+		+	+	2			+					+	2		+		+	+				+	+	29
Railroad	1998	1			1		+	+	3			+					+	2		1		1	+				2	+	51
Railroad	1999	1			1		+	+	2								+	1		+			+				1	+	21
Twin	1997					+	1	1	+			+		2		+	1	+		+		1	+		2			+	9
Twin	1998					+	1	1	1			+		2		+	1	+		+		+	1		1			+	9
Twin	1999					+	1	1	1			+		+		+	1	1		+			+		+			+	6
Non-chained treatment																													
Cunningham	1997		1	+			1	+	1		1	1			+	+	1	+		6			+		+				6
Cunningham	1998		1	+			1	+	2		1	+			+	+	+	1		12		+	1		+			+	57
Cunningham	1999		1	+		+	1		+		2	+			+	+	+	1		2			+					+	38
Dog Slopes	1997					9	2	3	1	+	+	1	+	+	+	+	1			+		1	2				+	+	2
Dog Slopes	1998					21	2	2	1	2	+	1	+	+	1	+	1			+		+	2				2	+	6
Dog Slopes	1999					33	2	1	+	1	+	1	+	+	+	1	1			+	+	+	1				1	+	12
Gilson	1997	+			1	2	+	2	1		+	1			+	+	1	6	1	2	8	2	1		1			+	9
Gilson	1998	+			1	2	+	1	1			1			+	+	+	5	+	1	2	1	1			+	14	+	33
Gilson	1999	+			1	2	+	+	1			+			+	1		5	+	1	1	1	1		+	+	2	2	51
Jericho	1997	+					1		1		+	2					+	+		2		1	+	+	+		1	+	33
Jericho	1998						1	+	2			1					+	+		1		+	1	+		+	9	+	69
Jericho	1999	+					1		5			+						+		5			1			+	3	+	69
Paul Bunyan	1997	+				2	2		+			+		+			1			1		+	2						3
Paul Bunyan	1998					5	5		1			+		+	+		+			2	+	1	1			+	1		27
Paul Bunyan	1999					5	5	+	+			+		+	+		+			1	+	+	2			+	6	1	33
Railroad	1997	+					+	+	2	+	+	+					+	2		+		+	1				1		57
Railroad	1998						+	1	3		+	+					+	1		+		+	+				5		85
Railroad	1999			+			+		1			+					+	1		+			3				2	+	16
Twin	1997		1			9	+	2	1			+	+	2		+	1	+		+		1	2		1	+		+	27
Twin	1998		1			9	+	1	1			+		2		+	1	+		1		+	1		+			1	68
Twin	1999		2			9	+	+	1			+		2		+	+	+		+			2		+			1	32

+ indicates mean values less than 0.5; other values are rounded to nearest whole number

* includes native *Descurainia pinnata* and exotic *Descurainia sophia*

Table 5b. Mean percent cover (100m^2 plots) of miscellaneous important species by treatment, site and year (Intensive Study sites: drilled, aerial-seeded slopes, non-seeded, old seedings, and intact treatments)

		Seeded			Native Grasses						Native Forbs and Shrubs									Exotic Forbs									
		Atriplex canescens	Kochia prostrata	Sanguisorba minor	Agropyron smithii	Agropyron spicatum	Oryzopsis hymenoides	Poa spp.	Sitanion hystrix	Stipa comata	Artemisia tridentata	Astragalus spp.	Chrysothamnus spp.	Crepis spp.	Cryptantha spp.	Gutierrezia sarothrae	Phlox spp.	Sphaeralcea spp.	Vicia americana	Alyssum desertorum	Camelina microcarpa	Descurainia spp.*	Lactuca serriola	Onopordum acanthium	Ranunculus testiculatus	Salsola pestifer	Sisymbrium altissimum	Tragopogon dubius	Bromus tectorum
Drilled Treatment																													
Jericho	1997			+	10		+		+		+	+					+	1		1		+	2	+		+	1		3
Jericho	1998			+	10		1		+		+	+						1		1		+	1	+			12		12
Jericho	1999			+	10		+		+		+							+		1							+		12
Twin	1997			1	+	1	+	1	+			+		1			1	1		+		+	+		+			+	2
Twin	1998			+		1	+	+	+					1			1	+											+
Twin	1999			+		+	+	1						+			1	+		+			+		+				+
Aerial-Seeded Slopes																													
Cunningham	1997			1		1	+	1	+			+		+	+		1					2	1					+	12
Cunningham	1998			1		1	+	1	+			+			+		+			+		2	1					+	27
Cunningham	1999			+		1	+	+	+						+		+			+		+	+						27
Non-seeded Treatment																													
Gilson	1997	+			1	1	+	1	1			2			+	+	+	2	1	2	+	2	1		4		1	+	18
Gilson	1998				1	1	+	4	2			2			+	+	+	1	2	+	1	2	1				12	+	56
Gilson	1999				4	1	+	+	1			+			+	1	+	1	+	+	5		1			+	2	1	63
Jericho	1997						1		2	+		+					+	+		+		+					+		36
Jericho	1998						1		2	+		+						+		+		1					5		69
Jericho	1999						1		2	+		+						+		+		+	+				12	+	63
Twin	1997				1	2		1	1		+	+		2		1	1	+				1	1		2	+		+	32
Twin	1998				1	2		1	1		+			1		1	+	+		+		1	1		1		+	1	85
Twin	1999				1	2	+	+	1		+	+		1		1	+	+		+			2		1		1	+	38
Old Seeding Treatment																													
Cunningham	1997		5	1			1	1	1		1			+	1		+	1		2			+		1				6
Cunningham	1998		2	1			1	+	1		1	+		+	+		+	2		1			+		+				3
Cunningham	1999		1	1			+				1	+			+			1		1			+		+				3
Gilson	1997				8	1	1	6	1			+	+	+		+	1	2		+	+	+	+		3	+		1	2
Gilson	1998				8	+	+	2	1			1	+	+		+	1	+		1		+	+		1		+	1	6
Gilson	1999				2	+	+	1	+			1	+			+	1	2		1	+		+		+			1	5
Intact (Unburned) Treatment																													
Cunningham	1997					2	+	1	1		1	+		+	+	+	2			1		+							9
Cunningham	1998					2	+	1	2		1	+			+	+	2			1			+		+				9
Cunningham	1999					2	+	1	1		1	+			+	+	2			1									9
Gilson	1997					1	+	2	2		4	1			+	+	+	1	2	1	+	+			1		+	+	27
Gilson	1998					1	+	6	2		4	1			+	+	+	1	2	1	+	+	1		+		+	+	27
Gilson	1999					1	+	2	2		4	+			+	+	+	1	1	1	+	+	1		+		+	+	27
Jericho	1997						1		12		24	1	12			1	+	+		1								+	18
Jericho	1998						1	+	12		18	+	9		+	1	+	+		1		+	+			+	+		21
Jericho	1999						1		6		17	+	9		+	1	+	+		1			+				+		18
Twin	1997					1	1	1	3		27	1	6	+	+		10	+							2			+	12
Twin	1998					2	1	2	2		21	1	6		+		13			+					1				18
Twin	1999					1	1	1	6		21	+	6		+		13			+					1		+		6

+ indicates mean values less than 0.5; other values are rounded to nearest whole number

* includes native *Descurainia pinnata* and exotic *Descurainia sophia*

Table 6. 1999 mean percent cover (basal, canopy, and relative), step point method

a. Dog Slopes Study Site

Scientific Name	Common Name	Chained (8 transects, 320 points) Basal	Canopy	Relative[1]	Non-chained (8 transects, 320 points) Basal	Canopy	Relative[1]
Seeded Species							
Agropyron cristatum	crested wheatgrass	3.4%	21.6%	17.2%	1.6%	7.5%	5.6%
Agropyron elongatum	tall wheatgrass	1.6%	5.6%	3.4%	1.9%	6.6%	3.1%
Agropyron intermedium	intermediate wheatgrass	3.1%	15.6%	9.1%	3.2%	8.1%	6.6%
Elymus junceus	Russian wildrye	0.3%	0.6%	0.3%	0%	0%	0%
Exotic Species							
Alyssum desertorum	desert alyssum	0%	0.3%	9.7%	0%	0.9%	11.9%
Bromus japonicus	Japanese brome	0%	0%	0%	0.3%	0.9%	2.2%
Bromus tectorum	cheatgrass	3.8%	13.1%	28.1%	4.1%	19.4%	43.8%
Camelina microcarpa	falseflax	0%	0%	0.3%	0%	0%	0%
Descurainia sophia	flixweed	0%	0%	0%	0%	0.3%	0%
Lactuca serriola	prickly lettuce	0.3%	0.3%	1.3%	0%	0%	0%
Sisymbrium altissimum	tumblemustard	0%	0%	0%	0%	0.6%	0.3%
Native Species							
Agropyron spicatum	bluebunch wheatgrass	8.8%	31.9%	18.4%	3.1%	25.9%	10.6%
Arabis holboellii	Holboell's rockcress	0%	0%	0%	0%	0.3%	0.3%
Arenaria fendleri	Fendler's sandwort	0.3%	0.3%	1.9%	0.6%	0.6%	3.4%
Astragalus calycosus	Torrey's milkvetch	0.3%	0.3%	0.3%	0%	0%	0%
Chrysothamnus nauseosus	rubber rabbitbrush	0%	0%	0%	0%	0.9%	0%
Gutierrezia sarothrae	broom snakeweed	0%	0.6%	0.3%	0%	0.3%	0.3%
Helianthus annuus	common sunflower	0%	0%	0%	0%	0%	0.6%
Koeleria macrantha	prairie junegrass	0%	0%	0.3%	0%	0%	0%
Lithospermum incisum	showy stoneseed	0.3%	0.3%	0.3%	0.9%	0.6%	0.9%
Machaeranthera canescens	hoary aster	0%	0%	0.3%	0%	0.3%	0%
Oryzopsis hymenoides	Indian ricegrass	0.3%	1.6%	0.9%	0.3%	3.8%	1.3%
Petradoria pumila	rock goldenrod	0%	0%	2.8%	0.9%	1.9%	5.0%
Phlox austromontana	desert phlox	0.6%	0.6%	1.6%	0.3%	0.3%	1.3%
Poa fendleriana	muttongrass	0%	0%	2.8%	0%	0.3%	1.9%
Sitanion hystrix	bottlebrush squirreltail	0%	0.3%	0.3%	0%	0%	0.6%
Stipa comata	needle-and-thread	0%	0.3%	0%	0.3%	0.3%	0.3%
Streptanthus cordatus	twistflower	0%	0%	0.3%	0%	0%	0%
	Bare Soil	35.0%	--	--	37.8%	--	--
	Litter	19.7%	--	--	14.7%	--	--
	Rock	22.2%	--	--	29.7%	--	--
	Cryptogams	0%	--	--	0.3%	--	--
	Dead Tree Canopy	--	14.4%	--	--	23.1%	--

[1] Relative cover was based on a dataset of the nearest plant in a 180° arc from each point

Table 6 (cont.). 1999 mean percent cover (basal, canopy, and relative), step point method

		b. Gilson Study Site					
		Chained (8 transects, 320 points)			Non-chained (8 transects, 320 points)		
Scientific Name	**Common Name**	**Basal**	**Canopy**	**Relative[1]**	**Basal**	**Canopy**	**Relative[1]**
Seeded Species							
Agropyron cristatum	crested wheatgrass	6.3%	29.1%	17.8%	0.6%	10.3%	2.5%
Ag. elongatum/intermedium	tall/intermed. wheatgrass	3.1%	17.8%	5.6%	1.6%	5.3%	2.2%
Atriplex canescens	fourwing saltbush	0%	0.3%	0%	0%	0%	0%
Bromus inermis	smooth brome	1.9%	8.8%	7.2%	1.6%	4.1%	2.5%
Elymus cinereus/junceus	Russian wildrye	0%	1.6%	0%	0%	0%	0%
Exotic Species							
Alyssum desertorum	desert alyssum	0%	0.3%	1.3%	0%	0.3%	1.3%
Bromus japonicus	Japanese brome	0%	0%	0%	0%	1.3%	1.3%
Bromus tectorum	cheatgrass	6.6%	31.6%	52.5%	22.8%	68.8%	80.3%
Camelina microcarpa	falseflax	0%	1.3%	0.6%	0%	1.9%	0.9%
Lactuca serriola	prickly lettuce	0%	0%	0%	0%	0.6%	1.3%
Salsola pestifer	Russian thistle	0%	0%	0%	0%	0%	0.3%
Sisymbrium altissimum	tumblemustard	0%	0.3%	0.3%	0%	0.9%	0.3%
Tragopogon dubius	yellow salsify	0%	0%	0%	0%	0.9%	0%
Native Species							
Agropyron smithii	western wheatgrass	2.2%	10.6%	10.9%	0%	3.4%	1.9%
Agropyron spicatum	bluebunch wheatgrass	0.3%	0.9%	0.6%	0.3%	3.8%	0.6%
Gutierrezia sarothrae	broom snakeweed	0%	0.3%	0.3%	0.6%	1.3%	1.3%
Oryzopsis hymenoides	Indian ricegrass	0%	0%	0%	0%	0.3%	0.3%
Phlox longifolia	longleaf phlox	0%	0%	0.3%	0%	0%	0%
Poa fendleriana	muttongrass	0.6%	0.9%	0.6%	0.3%	0.3%	0.3%
Sitanion hystrix	bottlebrush squirreltail	0%	0%	0.3%	0.6%	1.6%	0.6%
Sphaeralcea coccinea	common globemallow	0%	0%	1.6%	0%	1.6%	2.2%
	Bare Soil	36.9%	--	--	26.9%	--	--
	Litter	36.9%	--	--	39.4%	--	--
	Rock	5.0%	--	--	5.3%	--	--
	Cryptogams	0.3%	--	--	0%	--	--
	Dead Tree Canopy	--	13.4%	--	--	22.5%	--

[1] Relative cover was based on a dataset of the nearest plant in a 180° arc from each point

Table 6 (cont.). 1999 mean percent cover (basal, canopy, and relative), step point method

c. Paul Bunyan Study Site							
		Chained (8 transects, 320 points)			Non-chained (Seeded Only) (8 transects, 320 points)		
Scientific Name	**Common Name**	**Basal**	**Canopy**	**Relative[1]**	**Basal**	**Canopy**	**Relative[1]**
Seeded Species							
Agropyron cristatum	crested wheatgrass	6.3%	18.8%	29.1%	2.2%	6.9%	5.9%
Ag. elongatum/intermedium	tall/intermed. wheatgrass	4.1%	13.8%	15.3%	0.6%	4.4%	0.9%
Atriplex canescens	fourwing saltbush	0%	1.3%	0.3%	0%	0%	0%
Bromus inermis	smooth brome	0.3%	2.5%	3.4%	0%	0%	0.3%
Elymus cinereus/junceus	Russian wildrye	2.5%	5.6%	9.7%	0.3%	1.3%	0.9%
Exotic Species							
Alyssum desertorum	desert alyssum	0%	0%	0%	0.9%	4.1%	13.8%
Bromus tectorum	cheatgrass	5.3%	13.8%	33.8%	14.4%	45.6%	66.9%
Lactuca serriola	prickly lettuce	0%	0%	5.6%	0.3%	1.3%	3.8%
Salsola pestifer	Russian thistle	0.3%	0.3%	0.3%	0%	0.3%	0.3%
Sisymbrium altissimum	tumblemustard	0%	0%	0%	0%	2.2%	0.6%
Tragopogon dubius	yellow salsify	0%	0%	0%	0%	0.3%	0%
Native Species							
Agropyron spicatum	bluebunch wheatgrass	0.6%	2.5%	0.9%	2.5%	4.1%	2.5%
Astragalus eurekensis	Eureka milkvetch	0%	0%	0%	0.3%	0.3%	0.3%
Ephedra viridis	green ephedra	0%	0.3%	0%	0%	0%	0%
Gilia inconspicua	floccose gilia	0%	0%	0.3%	0%	0%	0.3%
Oryzopsis hymenoides	Indian ricegrass	0%	0.6%	0.9%	0.9%	8.2%	2.5%
Phlox austromontana	desert phlox	0%	0%	0%	0%	0%	0.3%
Sitanion hystrix	bottlebrush squirreltail	0%	0%	0.3%	0%	0%	0%
	Bare Soil	54.1%	--	--	45.0%	--	--
	Litter	22.5%	--	--	26.9%	--	--
	Rock	4.1%	--	--	5.6%	--	--
	Cryptogams	0%	--	--	0%	--	--
	Dead Tree Canopy	--	11.9%	--	--	30.6%	--

[1] Relative cover was based on a dataset of the nearest plant in a 180° arc from each point

Table 6 (cont.). 1999 mean percent cover (basal, canopy, and relative), step point method

d..Jericho Study Site

		Drilled (8 transects, 320 points)			Seeded Only (4 transects, 160 points)		
Scientific Name	**Common Name**	**Basal**	**Canopy**	**Relative**[1]	**Basal**	**Canopy**	**Relative**[1]
Seeded Species							
Agropyron cristatum	crested wheatgrass	15.0%	50.0%	51.3%	1.3%	6.9%	1.3%
Ag. elongatum/intermedium	tall/intermed. wheatgrass	4.4%	16.6%	14.7%	0%	1.9%	0.6%
Atriplex canescens	fourwing saltbush	0%	0%	0%	0%	0.6%	0%
Elymus cinereus/junceus	Russian wildrye	0%	1.6%	2.2%	0%	0%	0%
Exotic Species							
Alyssum desertorum	desert alyssum	0%	0%	0%	0%	0%	1.9%
Bromus tectorum	cheatgrass	3.1%	12.5%	24.7%	20.6%	71.3%	95.0%
Erodium cicutarium	storksbill	0%	0%	0%	0%	0.6%	0%
Sisymbrium altissimum	tumblemustard	0%	0%	0%	0%	1.9%	0%
Native Species							
Agropyron smithii	western wheatgrass	0.6%	8.1%	6.6%	0%	0%	0%
Agropyron spicatum	bluebunch wheatgrass	0%	0%	0%	0%	0.6%	0%
Chrysothamnus viscidiflorus	rubber rabbitbrush	0%	0%	0%	0%	0.6%	0%
Hilaria jamesii	galleta	0%	0%	0%	0%	0.6%	0%
Macaeranthera canescens	hoary aster	0%	0%	0%	0%	0.6%	0%
Sitanion hystrix	bottlebrush squirreltail	0.3%	0.3%	0.6%	0%	0.6%	1.3%
	Bare Soil	38.1%	--	--	25.6%	--	--
	Litter	38.1%	--	--	46.3%	--	--
	Rock	0.3%	--	--	6.3%	--	--
	Cryptogams	0%	--	--	--	--	--
	Dead Tree Canopy	--	0%	--	--	23.8%	--

e. Railroad Study Site

		Late Chaining[2] (4 transects, 160 points)		
Scientific Name	**Common Name**	**Basal**	**Canopy**	**Relative**[1]
Seeded Species				
Agropyron cristatum	crested wheatgrass	0.6%	6.3%	30.0%
Ag. elongatum/intermedium	tall/intermed. wheatgrass	1.9%	4.4%	10.6%
Bromus inermis	smooth brome	0.6%	0.6%	4.4%
Sanguisorba minor	small burnet	0%	0%	0.6%
Exotic Species				
Bromus tectorum	cheatgrass	2.5%	21.3%	36.3%
Lactuca serriola	prickly lettuce	0.6%	5.6%	7.5%
Sisymbrium altissimum	tumblemustard	0%	11.3%	8.1%
Tragopogon dubius	yellow salsify	0%	0%	0.6%
Triticum aestivum	cultivated wheat	0.6%	0.6%	0.6%
Native Species				
Phlox longifolia	longleaf phlox	0%	0%	0.6%
Sitanion hystrix	bottlebrush squirreltail	0.6%	0.6%	0.6%
Sphaeralcea grossulariifolia	gooseberry globemallow	0%	0.6%	0%
	Bare Soil	58.1%	--	--
	Litter	33.8%	--	--
	Rock	0.6%	--	--
	Cryptogams	0%	--	--
	Dead Tree Canopy	--	2.5%	--

[1] Relative cover was based on a dataset of the nearest plant in a 180° arc from each point
[2] The late chaining at the Railroad site was burned, reseeded, and double-chained in 1998-1999, two years later than other treatments

Table 7. Mean percent cover of categories in chained and non-chained (including aerial seeding) treatments at expanded Jericho study site, 1998-2000, showing effects of 1999 Railroad fire.

	Chained[1]			Non-chained (including non-seeded)[2]		
	1998	1999 (pre-fire)	2000 (post-fire)	1998	1999 (pre-fire)	2000 (post-fire)
Percent Cover by Category (100-meter-square plots)						
Bare Soil	21.7	22.5	64.3	9.9	9.0	56.7
Litter	6.8	12.8	4.7	2.5	14.8	9.9
Rock (>1cm)	3.4	3.5	7.3	2.3	1.5	7.5
Cryptogams	0.3	0.5	0	0.3	0.1	0
Vascular Plants	67.9	60.8	23.8	85.4	75.0	26.0
Dead Tree Canopy	5.2	5.0	0	8.2	8.0	0
Percent Cover by Category (one-meter-square plots)						
Bare Soil	35.3	32.0	67.2	9.6	6.9	44.0
Litter	4.5	14.7	3.2	3.0	14.5	15.8
Rock (>1cm)	2.2	2.0	3.9	0.8	1.2	4.3
Cryptogams	0.5	0.6	0	0	0	0
Vascular Plants	57.5	50.8	25.8	86.9	77.7	36.0
Dead Tree Canopy	0	0.4	0	1.5	2.0	9.0
Percent Cover of Vascular Plant Categories (100-meter-square plots)						
Trees	0	0	0	+	+	0
Shrubs	0.8	1.0	0.1	+	0.1	+
Forbs	5.5	1.6	2.3	9.4	11.8	9.1
Grasses (Total)	61.8	58.4	21.4	76.0	62.4	16.9
Exotic Grasses	21.3	16.6	2.1	69.3	55.1	13.0
Native Grasses	3.5	3.4	4.5	5.4	3.7	1.9
Seeded Grasses	37.0	38.4	14.8	1.6	2.2	2.0

[1]chained treatment here includes 12 plots located within an area that was aerially seeded and chained following 1996 wildfires, then reburned in 1999
[2]non-chained treatment here includes 10 plots which received varying degrees of aerial seeding treatment following 1996 wildfires, then reburned in 1999
+ indicates mean values less than 0.05; other values are rounded to nearest tenth

Table 8. Mean percent cover of species in chained and non-chained (including aerial seeding) treatments at expanded Jericho study site, 1998-2000, showing effects of 1999 Railroad fire.

Species Name	Common Name		Chained[1] 1998	Chained[1] 1999 (pre-burn)	Chained[1] 2000 (post-burn)	Non-chained (including non-seeded)[2] 1998	Non-chained (including non-seeded)[2] 1999 (pre-burn)	Non-chained (including non-seeded)[2] 2000 (post-burn)
Seeded Species								
Agropyron cristatum	crested wheatgrass	P	12.4 (9.0)[3]	15.3 (14.0)	11.3 (7.3)	0.3 (0.1)	0.6 (0.1)	0.4
Agropyron elongatum/ intermedium	tall/intermediate wheatgrass	P	7.8 (7.0)	11.3 (9.0)	8.5 (6.3)	0.5 (1.2)	0.9 (2.5)	0.8 (2.5)
Atriplex canescens	fourwing saltbush		0.4 (0.1)	0.9 (0.3)	0.3	0	0	0
Bromus inermis	smooth brome	P	7.2 (12.3)	7.0 (15.5)	5.1 (8.1)	0.5	0.5	0.2
Elymus cinereus/junceus	Russian/basin wildrye	P	2.4 (2.0)	0.5 (0.3)	0.5 (0.3)	0.2 (0.5)	0.1 (0.4)	0.1 (0.2)
Medicago sativa	alfalfa	P	0.1	+	0	0	0	0.1
Melilotus officinalis	yellow sweetclover	A	+	0	0	0	0	0.1
Sanguisorba minor	small burnet	P	0	0	0	0	0	0.1
Exotic Species								
Alyssum desertorum	desert alyssum	A	0.3 (+)	0.3 (+)	0.3 (0.1)	0.4 (1.7)	1.9 (2.1)	2.0 (2.0)
Bromus japonicus	Japanese brome	A	0.1	0.1	+	0	0	0
Bromus tectorum	cheatgrass	A	17.2 (22.9)	13.2 (13.4)	3.0 (2.6)	72.0 (72.5)	62.8 (66.5)	18.8 (18.8)
Camelina microcarpa	falseflax	A	0	0	0	0	0	0.1
Chenopodium album	lambsquarter	A	0	0	0	0.1	0	0
Descurainia sophia	tansymustard	A	0	0	0.2	0	0	0.3
Erodium cicutarium	storksbill	A	0.1	+	+	1.8 (1.5)	1.8 (0.2)	1.8 (3.2)
Lactuca serriola	prickly lettuce	A	0.2	0.1 (+)	0.3 (0.1)	0.1	0.3	0.5 (1.1)
Malcolmia africana	African mustard	A	0.1	0	0.1	0.1	0	0
Marrubium vulgare	horehound	P	+	+	0	0	0	0
Onopordum acanthium	Scotch thistle	B	0.1	0	+	0.1	0.1	0.2
Salsola iberica	Russian thistle	A	+	+	0.1	0	0.1	0.2
Sisymbrium altissimum	tumblemustard	A	4.9 (3.3)	1.3 (4.0)	1.0 (0.5)	9.8 (10.1)	10.5 (9.1)	8.0 (10.8)
Tragopogon dubious	yellow salsify	P	0	0	0.1	0.1	0.2	0.2 (0.1)
Native Grasses								
Agropyron smithii	western wheatgrass	P	0	0	0	0.3 (2.0)	0.3 (2.5)	0.3 (4.0)
Agropyron spicatum	bluebunch wheatgrass	P	0	0	0	0.1	0	0
Oryzopsis hymenoides	Indian ricegrass	P	3.0 (4.8)	2.7 (3.8)	0.6 (0.8)	0.9 (0.1)	1.1 (0.4)	0.6 (0.4)
Poa fendleriana	muttongrass	P	0	0	0	0	0	0
Sitanion hystrix	bottlebrush squirreltail	P	0.9	0.6 (0.1)	0.7 (0.3)	1.5 (0.2)	2.7 (0.7)	1.2 (0.3)
Stipa comata	needle-and-thread	P	0	0	0	0.1	0.1	0.1
Native Shrubs and Trees								
Chrysothamnus viscidiflorus	viscid rabbitbrush	P	0.1	0.1	0	0	0	0
Chrysothamnus nauseosus	rubber rabbitbrush	P	0	0	0	0.1	0.1	0.1
Juniperus osteosperma	Utah juniper	P	0	0	0	0.1	0.1	0
Opuntia polyacantha	plains prickly pear	P	0.1 (0.1)	0.1 (0.4)	0.1 (0.3)	0	0	0

[1]chained treatment here includes 12 plots located within an area that was aerially seeded and chained following 1996 wildfires, then reburned in 1999
[2]non-chained treatment here includes 10 plots which received varying degrees of aerial seeding treatment following 1996 wildfires, then reburned in 1999
[3]cover value on left is mean percent cover of 100m^2 plots; value in parentheses is mean percent cover of 1m^2 plots, if greater than zero
+ indicates mean values less than 0.05; other values are rounded to nearest tenth

Table 8 (cont). Mean percent cover of species in chained and non-chained (including aerial seeding) treatments at expanded Jericho study site, 1998-2000, showing effects of 1999 Railroad fire.

Species Name	Common Name		Chained[1] 1998	Chained[1] 1999 (pre-burn)	Chained[1] 2000 (post-burn)	Non-chained (including non-seeded)[2] 1998	Non-chained (including non-seeded)[2] 1999 (pre-burn)	Non-chained (including non-seeded)[2] 2000 (post-burn)
Native Forbs								
Amaranthus blitoides	prostrate pigweed	A	0[3]	0	0	0	0	0.1
Ambrosia acanthicarpa	bur ragweed	A	0	0	+	0	0	0.2
Astragalus lentiginosus	freckled milkvetch	P	0.2	0.2	0.1	0.3	0.2	0.3 (0.1)
Astragalus calycosus	Torrey's milkvetch	P	+	0.1	0	0.1	0.1	0
Astragalus eurekensis	Eureka milkvetch	P	+	+	0	0	0.1	0.1
Camissonia boothii	Booth's camissonia	A	0	0	+	0	0	0.1 (0.1)
Camissonia walkeri	Walker's camissonia	A	0	0	0	0	0	0.1
Chaenactis douglasii	Douglas' dustymaiden	P	0.3	+	0	0	0	0
Chenopodium spp.	pigweed	A	0	0	+	0	0	0.2
Cryptantha spp.	cryptanth	?	+	0	0	0	0	0
Descurainia pinnata	pinnate tansymustard	A	0.4 (0.3)	0 (0.1)	0	0.7 (2.4)	0.1	0
Eriogonum deflexum	skeleton buckwheat	A	+	0	0.2 (+)	0	0	0.1
Eriogonum hookeri	Watson's buckwheat	A	0	0	+ (+)	0	0	0.1
Eriogonum maculatum	spotted buckwheat	A	0	0	+	0	0	0.2 (0.1)
Euphorbia micromera	tiny spurge	A	0	0	0.1	0	0	0.1
Gilia inconspicua	floccose gilia	A	0.2 (0.2)	+ (+)	0.7 (0.2)	0.1 (0.1)	0.1	0.5 (0.5)
Gilia leptomeria	common gilia	A	0	0	0.1 (+)	0	0	0.1 (0.3)
Helianthus annuus	common sunflower	A	0.1	0.1	0.5 (0.3)	0.2	0.1	0.9 (0.1)
Lappula occidentalis	western stickseed	A	+	0	0.1	0.1 (0.1)	0	0.1
Lepidium montanum	mountain pepperplant	P	0	0	0	0	0.1	0
Lygodesmia grandiflora	showy rushpink	P	+	+	0.1	0	0	0.1
Machaeranthera canescens	hoary aster	P	+	0	0	0	0	0
Mentzelia albicaulis	whitestem blazingstar	A	0	0	0.1 (0.1)	0	0	0.5 (0.4)
Nicotiana attenuata	coyote tobacco	A	0	0	+	0	0	0
Oenothera caespitosa	tufted evening primrose	P	0	0	0	0.1	0.1	0.1
Phlox longifolia	longleaf phlox	P	+	0.1	0	0.1	0	0
Senecio multilobatus	Uinta groundsel	P	+	+	0	0	0	0
Sphaeralcea grossulariifolia	gooseberry globemallow	P	0.7	0.3	0.2	0.3 (0.8)	0.3 (1.2)	0.3
Stanleya pinnata	prince's plume	P	+	+	+	0	0	0
Streptanthus cordatus	twistflower	P	+	+	+	0	0	0
Verbena bracteata	prostrate verbena	P	0	0	0	0.1	0.1	0.1

[1]chained treatment here includes 12 plots located within an area that was aerially seeded and chained following 1996 wildfires, then reburned in 1999
[2]non-chained treatment here includes 10 plots which received varying degrees of aerial seeding treatment following 1996 wildfires, then reburned in 1999
[3]cover value on left is mean percent cover of 100m² plots; value in parentheses is mean percent cover of 1m² plots, if greater than zero
+ indicates mean values less than 0.05; other values are rounded to nearest tenth

Table 9. Location and other attributes of Extensive Study transects

	Latitude	Longitude	Elevation (feet)	Range of % Slope	Principal Aspect	Trees/ha[1] Juniper	Trees/ha[1] Pinyon	Tree Canopy Cover (%)[2]	Date 1997[3]	Date 1999[3]	Grazing 1997[4]	Grazing 1999[4]
Chained Treatment												
Big Cherry-27	N 39 45 35.9	W 112 22 19.9	5700	6-9	west	191	0	3	Oct09	Jun23	na	na
Boutler-2	N 39 57 58.3	W 112 13 51.0	6250	4-9	south	1176	82	12	Sep16	Jun28	na	na
Boutler-53	N 39 58 20.0	W 112 12 50.0	6550	6-7	south	492	55	23	Nov10	Jun28	l/m	na
Center Horse-36	N 38 36 33.2	W 112 39 35.7	6120	2-3	west	0	0	0	Oct15	Jun17	na	na
East Horse-35	N 38 36 10.3	W 112 39 05.2	6070	3-5	north	0	0	0	Oct15	Jun17	na	na
Eight Mile-9	N 39 12 10.3	W 112 10 57.7	6040	8-14	south	1039	55	4	Sep24	Jun17	na	l
Flowell-10	N 39 04 38.9	W 112 30 26.0	4980	3-6	northwest	0	0	0	Sep25	Jul01	na	na
Little Sage-30	N 39 36 32.2	W 112 05 37.2	5100	4-5	east	273	0	5	Oct10	Jul06	na	na
North Cherry-48	N 39 50 53.2	W 112 21 66.7	6060	10-22	south	957	0	17	Nov03	Jun24	na	na
North Gilson-28	N 39 39 16.0	W 112 11 34.4	5790	11-17	east	547	0	11	Oct09	Jun30	na	na
South Eric/Pole Ck-19	N 39 51 08.9	W 112 24 30.2	6200	5-10	west	137	0	5	Oct02	Jun24	l/m	l/m
South Horse-38	N 38 40 09.7	W 112 39 16.9	6110	3-12	northwest	383	0	3	Oct16	Jun14	na	na
South Horse-44	N 38 37 53.1	W 112 44 09.1	5330	2-3	southeast	0	0	0	Oct29	Jun15	na	na
South Mud-18	N 39 45 54.9	W 112 12 33.1	5280	3-5	west	0	0	0	Oct01	Jun22	h	na
Tanner Ck-6	N 39 43 26.2	W 112 13 53.4	4210	1	south	0	0	0	Sep19	Jun23	na	na
West Horse-37	N 38 36 17.4	W 112 43 51.7	5600	12-13	west	0	0	0	Oct16	Jun16	na	na
West Horse-47	N 38 37 46.3	W 112 41 57.9	5910	2-8	northwest	301	0	1	Oct30	Jul14	na	na
Aerial-seeded (Non-chained) and Non-seeded Treatments												
Baker Cyn/N Horse-39	N 38 39 06.9	W 112 38 24.5	6150	2	southwest	328	0	4	Oct17	Jun14	na	na
Baker Cyn/N Horse-43	N 38 41 20.3	W 112 39 72.0	5690	8-10	southwest	519	0	5	Oct28	Jun15	na	na
Big Mud-17	N 39 48 58.7	W 112 15 34.7	5870	4-18	northeast	465	0	13	Oct01	Jun21	m/l	na/l
Boutler-3	N 39 57 58.3	W 112 13 51.0	6250	4-9	south	1230	629	25	Sep17	Jun28	na	na
Leamington-23 (no seed)	N 39 41 11.4	W 112 12 47.6	4990	2-4	north	0	0	0	Oct06	Jun30	na	na
Little Mud-14	N 39 54 00.6	W 112 15 20.1	6000	5-6	east	1504	0	13	Sep29	Jul01	m/h	l/m
Middle Mud-16	N 39 51 32.4	W 112 14 31.9	5330	4-7	north	465	0	22	Sep30	Jun21	h	l
North Eric-51	N 39 48 00.8	W 112 17 65.1	5650	4-6	south	793	0	11	Nov07	Jun21	na	na
North Gilson-29	N 39 39 16.0	W 112 11 34.4	5790	12-20	east	492	0	3	Oct10	Jun30	na	na
Sabie-4	N 39 54 44.3	W 112 15 06.7	6080	3-5	east	930	82	21	Sep17	Jul01	m/l/na	na
Sage Valley-50	N 39 36 00.4	W 112 03 95.2	5760	3-4	east	574	0	10	Nov06	Jul06	na	na
Sevier-Sara-49	N 39 34 73.2	W 112 08 34.3	5290	8-9	north	0	0	0	Nov04	Jul07	na/l	h
South Eric/Black Mtn-21	N 39 42 06.5	W 112 18 19.7	6040	2-3	west	437	0	6	Oct04	Jul01	na	na
South Gilson-41	N 39 36 48.5	W 112 09 00.3	5270	9-19	south/east	738	0	13	Oct23	Jul07	na	na
Twin-13 (no seed)	N 38 36 30.1	W 112 44 17.1	5960	1	west	0	0	0	Sep26	Jun16	na	na
Twin-42 (no seed)	N 38 41 10.4	W 112 39 45.3	5840	7-8	northeast	0	0	0	Oct28	Jun15	na	na
Twin-46 (no seed?)	N 38 36 04.7	W 112 43 93.1	5410	3	west	0	0	0	Oct20	Jun16	na	na
West Fork-34	N 39 36 57.9	W 112 02 04.0	5740	4-8	north	1012	0	16	Oct14	Jul06	na	na/l
West Hills-33	N 39 36 53.1	W 111 57 42.7	6120	9-10	east	1859	0	17	Oct14	Jul07	na	na
Drilled Treatment												
Leamington-15	N 39 42 24.9	W 112 11 18.8	5300	2	south	0	0	0	Sep30	Jun22	na	na
Leamington-20	N 39 44 18.1	W 112 10 25.8	5660	3	south	0	0	0	Oct02	Jun22	na	na
Leamington-22	N 39 41 11.4	W 112 12 47.6	4990	2-3	north	0	0	0	Oct06	Jun30	na	na
Leamington-32	N 39 40 35.0	W 112 07 13.3	5400	6-8	southwest	0	0	0	Oct13	Jun29	na	na
North Eric/L Sahara-5	N 39 43 22.7	W 112 13 45.0	5210	2	north	0	0	0	Sep19	Jun23	na	na
North Eric/L Sahara-7	N 39 43 11.9	W 112 13 07.6	5240	2-10	east	0	0	0	Sep23	Jun23	l/na	na
North Eric/L Sahara-25	N 39 44 32.6	W 112 17 18.7	5410	2-5	southwest	0	0	0	Oct08	Jun23	na	na
South Eric/L Sahara-8	N 39 43 10.6	W 112 13 09.3	5160	2	south	0	0	0	Sep23	Jun23	l/na	na
South Eric/L Sahara-24	N 39 43 15.2	W 112 16 14.6	5350	3-4	northwest	0	0	0	Oct07	Jun22	na	na
South Eric/L Sahara-26	N 39 44 32.1	W 112 17 20.6	5490	3-5	south	0	0	0	Oct08	Jun23	na	na
South Eric/L. Sahara-31	N 39 43 42.0	W 112 18 57.2	5290	3	west	0	0	0	Oct13	Jun22	na	na
Twin-1	N 38 34 23.2	W 112 44 36.5	5950	2-3	south	0	0	0	Sep12	Jul08	na	l/m
Twin-11	N 38 37 38.8	W 112 39 01.3	6220	2	south	0	0	0	Sep25	Jun09	na	m
Twin-12	N 38 36 30.1	W 112 44 17.1	5960	1-2	northwest	0	0	0	Sep26	Jun16	na	l
Twin-40	N 38 41 10.4	W 112 39 45.3	5840	5-6	northeast	0	0	0	Oct17	Jun15	na	na
Twin-45	N 38 36 04.7	W 112 43 93.1	5410	3-7	west	0	0	0	Oct29	Jun16	na	l

[1] density of juniper and pinyon based on post-fire (1997) counts of dead trees in 3m x 400ft belt transects
[2] mean percent canopy cover for 100m^2 plots, of dead trees as if foliated, whether trees in standing or fallen (i.e, chained) position, measured 1999
[3] date of data collection in year indicated
[4] grazing intensities as recorded for 100m^2 plots for year indicated, measured on an ordinal scale: na=not apparent, l=light, m=moderate, h=heavy

Table 10. Soils of Extensive Study Transects

	Soil Series	Reference[1]
Chained Treatment		
Big Cherry-27	unknown	
Boutler-2	Borvant cobbly loam, 8-25% slopes (BgD) and/or Juab loam, 2-4% slopes (JbB)	FN 32
Boutler-53	Donnardo stony loam, 2-8% slopes (DdC), and/or Deer Creek cobbly loam, 6-25% slopes (DbD)	FN 32
Center Horse-36	Kessler-Penoyer association, 1-20% slopes (KPE), and/or Mill Hollow-Pharo association, 2-30% slopes (MNF)	BCF 15
East Horse-35	Mill Hollow-Pharo association, 2-30% slopes (MNF)	BCF 15
Eight Mile-9	unknown	
Flowell-10	unknown	
Little Sage-30	Juab loam, 4-8% slopes (JbC)	FN 98
North Cherry-48	Sumine-Reywat-Rock outcrop complex, 10-30% slopes (SsE)	FN 51
North Gilson-28	Donnardo stony loam, 2-8 % slopes (DdC) and/or Saxby-Rock outcrop complex, 30-70% slopes (SdF)	FN 90
South Eric/Pole Ck-19	Borvant cobbly loam, 8-25% slopes (BgD)	FN 50
South Horse-38	Pharo very cobbly loam, 3-30% slopes (PVF)	BCF 11
South Horse-44	Penoyer silt loam, 1-3% slopes (PGB), and/or Hiko Peak coarse sandy loam, 3-30% slopes (HIF)	BCF 14
South Mud-18	Wales loam, dry, 2-4% slopes (WdB)	FN 68
Tanner Ck-6	Genola silt loam, 1-2% slopes (GbB), and/or Truesdale fine sandy loam, 2-4% slopes (TdB)	FN 76
West Horse-37	Kessler-Hiko Peak association, 1-20% slopes (KME)	BCF 14
West Horse-47	Kessler-Hiko Peak association, 1-20% slopes (KME), and/or Penoyer silt loam, 1-3% slopes (PGB)	BCF 14
Aerial-seeded (Non-chained) and Non-seeded Treatments		
Baker Cyn/N Horse-39	Red Rock silt loam, 1-3% slopes (RhB)	BCF 11
Baker Cyn/N Horse-43	Pharo very cobbly loam, 3-30% slopes (PVF)	BCF 7
Big Mud-17	Jericho gravelly fine sandy loam, 4-15% slopes (JaD)	FN 59
Boutler-3	Borvant cobbly loam, 8-25% slopes (BgD) and/or Juab loam, 2-4% slopes (JbB)	FN 32
Leamington-23 (no seed)	Truesdale fine sandy loam, 2-4% slopes (TdB)	FN 83
Little Mud-14	Justesen loam, 4-15% slopes (JeD), and/or Fontreen-Borvant complex, 2-25% slopes (FfD)	FN 44
Middle Mud-16	Shabliss very fine sandy loam, 2-5% slopes (SfC), and or Jericho gravelly fine sandy loam, 4-15% slopes (JaD)	FN 52
North Eric-51	Jericho gravelly fine sandy loam, 4-15% slopes (JaD)	FN 59
North Gilson-29	Donnardo stony loam, 2-8% slopes (DdC) and/or Saxby -Rock outcrop complex, 30-70% slopes (SdF)	FN 90
Sabie-4	Fontreen stony loam, 3-35% slopes (FeD)	FN 44
Sage Valley-50	Juab loam, 2-4% slopes (JbB), and/or Borvant cobbly loam, 8-25% slopes (BgD)	FN 98
Sevier-Sara-49	Hiko Peak stony sandy loam, 4-8% slopes (HdC)	FN 104
South Eric/Black Mtn-21	Shabliss very fine sandy loam, 2-5% slopes (SfC), and/or Linoyer very fine sandy loam, 2-5% slopes (LaC)	FN 82
South Gilson-41	Borvant cobbly loam, 8-25% slopes (BgD)	FN 97
Twin-13 (no seed)	Penoyer silt loam, 1-3% slopes (PGB)	BCF 14
Twin-42 (no seed)	Pharo very cobbly loam, 3-30% slopes (PVF) and/or Red Rock silt loam, 1-3% slopes (RhB),	BCF 7
Twin-46 (no seed?)	Kessler-Hiko Peak association, 1-20% slopes (KME)	BCF 14
West Fork-34	Borvant-Reywat complex, 8-30% slopes (BhD)	FN 98
West Hills-33	Borvant cobbly loam, 8-25% slopes (BgD) and/or Amtoft, moist-Rock outcrop, 8-30% slopes (AdE)	FN 99
Drilled Treatment		
Leamington-15	Linoyer very fine sandy loam, 2-5% slopes (LaC), and/or Truesdale fine sandy loam, 2-4% slopes (TdB)	FN 83
Leamington-20	Medburn fine sandy loam, 2-4% slopes (MfB)	FN 76
Leamington-22	Truesdale fine sandy loam, 2-4% slopes (TdB)	FN 83
Leamington-32	Hiko Peak stony sandy loam, 4-8% slopes (HdC), and/or Linoyer very fine sandy loam, 2-5% slopes (LaC)	FN 84
North Eric/L Sahara-5	Truesdale fine sandy loam, 2-4% slopes (TdB)	FN 76
North Eric/L Sahara-7	Linoyer very fine sandy loam, 1-2% slopes (LaB), and/or Truesdale fine sandy loam, 2-4% slopes (TdB)	FN 76
North Eric/L Sahara-25	Shabliss very fine sandy loam, 2-5% slopes (SfC)	FN 75
South Eric/L Sahara-8	Linoyer very fine sandy loam, 1-2% slopes (LaB)	FN 76
South Eric/L Sahara-24	Truesdale fine sandy loam, 2-4% slopes (TdB)	FN 75
South Eric/L Sahara-26	Shabliss very fine sandy loam, 2-5% slopes (SfC)	FN 75
South Eric/L. Sahara-31	Genola silt loam, 1-2% slopes (GbB), and/or Shabliss very fine sandy loam, 2-5% slopes (SfC)	FN 75
Twin-1	Penoyer silt loam, 1-3% slopes (PGB)	BCF 18
Twin-11	Ushar-Mill Hollow association, 1-10% slopes, eroded (UOD2)	BCF 15
Twin-12	Penoyer silt loam, 1-3% slopes (PGB)	BCF 14
Twin-40	Red Rock silt loam, 1-3% slopes (RhB)	BCF 7
Twin-45	Kessler-Hiko Peak association, 1-20% slopes (KME)	BCF 14

[1] references to soil surveys and map page numbers used to determine soil series:
BCF=Stott, L.H., and M.E. Olsen. 1976. Soil Survey of Beaver-Cove Fort area, Utah. USDA Soil Conservation Service.
FN=Trickler, D.L., and D.T. Hall. 1984. Soil Survey of Fairfield-Nephi area, Utah. USDA Soil Conservation Service.

Table 11. 1997 and 1999 mean percent cover ($100m^2$ plots) by category, Extensive Study main transects

	Bare Soil		Litter		Rock >1cm		Crypto-gams		Vascular Plants		Shrubs & Trees		Forbs		Exotic Grasses		Native Grasses		Seeded Grasses	
	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999
Chained Treatment																				
Big Cherry-27	53	57	15	14	1	1	6	1	25	28	2	1	10	2	4	13	7	7	2	6
Boutler-2	55	52	16	19	14	9	0	0	15	21	+	+	4	3	+	1	+	+	11	16
Boutler-53	48	46	23	19	5	3	0	0	25	32	0	+	3	1	+	1	3	4	19	25
Center Horse-36	42	47	5	12	29	19	0	0	25	23	+	+	5	5	3	1	4	2	13	14
East Horse-35	40	35	5	16	25	20	0	0	31	30	0	+	6	5	4	4	4	4	18	18
Eight Mile-9	39	45	18	21	23	8	0	0	21	26	2	1	6	3	+	1	4	8	8	14
Flowell-10	34	68	28	14	0	+	0	0	39	18	0	0	22	12	17	3	0	0	0	3
Little Sage-30	40	48	11	14	10	1	0	0	39	37	2	2	6	5	6	5	15	19	11	6
North Cherry-48	34	42	15	18	25	23	0	0	26	18	0	+	11	1	2	5	+	+	13	10
North Gilson-28	46	38	13	22	14	6	0	0	28	35	0	0	13	10	3	3	1	1	10	20
South Eric/Pole Ck-19	41	51	16	14	14	10	0	0	29	25	1	1	7	1	2	3	5	2	14	17
South Horse-38	47	40	12	24	8	3	0	0	33	34	+	+	6	5	1	1	7	9	19	19
South Horse-44	69	71	10	10	0	1	0	0	21	18	0	0	4	4	1	3	3	1	12	10
South Mud-18	60	46	10	13	0	2	0	0	30	40	0	0	2	1	8	3	0	+	20	37
Tanner Ck-6	43	8	23	10	0	0	0	0	35	83	5	8	7	1	23	70	0	0	1	4
West Horse-37	31	22	3	18	34	32	0	0	32	29	0	+	8	2	12	7	0	+	12	20
West Horse-47	43	51	19	20	12	5	0	0	27	24	+	0	5	3	6	6	2	3	14	12
Treatment Mean	**45**	**45**	**14**	**16**	**13**	**8**	**+**	**+**	**28**	**30**	**1**	**1**	**7**	**4**	**5**	**8**	**3**	**4**	**12**	**15**
Aerial-seeded (Non-chained) Treatment																				
Baker Cyn/N Horse-39	59	43	9	22	5	3	0	0	28	33	1	1	8	6	7	12	9	9	3	4
Baker Cyn/N Horse-43	56	40	7	21	12	8	0	0	25	31	+	+	7	7	1	7	4	9	6	9
Big Mud-17	58	43	12	21	4	1	3	3	23	33	1	2	2	2	2	9	13	15	5	6
Boutler-3	74	53	9	19	10	4	0	0	8	25	0	0	1	3	0	1	1	1	5	20
Little Mud-14	68	62	15	14	2	+	0	0	16	24	+	+	4	4	+	3	5	4	7	13
Middle Mud-16	65	52	10	14	0	0	0	0	26	34	0	+	5	5	1	2	12	2	8	25
North Eric-51	55	43	14	16	4	1	3	+	25	39	0	+	7	3	2	8	12	23	3	4
North Gilson-29	50	42	6	16	16	3	0	0	28	39	+	+	12	5	11	22	2	5	3	7
Sabie-4	68	53	11	14	2	1	0	7	19	26	+	+	2	2	+	3	5	3	12	18
Sage Valley-50	48	49	13	12	9	1	0	2	31	36	1	2	10	7	6	16	11	7	3	5
Sevier-Sara-49	39	42	8	9	7	3	0	+	46	46	+	1	11	3	27	32	3	+	5	10
South Eric/Black Mtn-21	75	51	11	17	4	1	2	0	8	32	0	0	+	1	1	17	+	+	7	14
South Gilson-41	30	34	11	11	29	19	5	9	25	28	1	1	12	5	5	14	4	2	4	6
West Fork-34	43	51	10	11	26	7	0	0	21	32	1	+	6	5	1	10	9	9	4	8
West Hills-33	49	34	8	15	25	4	0	0	19	48	1	+	7	14	2	12	5	10	5	11
Treatment Mean	**56**	**46**	**10**	**15**	**10**	**4**	**1**	**1**	**23**	**34**	**+**	**1**	**6**	**5**	**4**	**11**	**6**	**7**	**5**	**11**
Drilled Treatment																				
Leamington-15	45	48	14	22	0	1	0	0	41	30	+	+	15	5	20	10	2	3	5	12
Leamington-20	68	57	8	10	0	2	1	0	24	31	+	1	3	1	2	1	+	+	19	28
Leamington-22	59	66	10	11	7	3	0	0	25	20	0	+	5	+	3	+	+	+	16	19
Leamington-32	35	51	4	18	16	5	3	0	43	26	+	+	9	3	19	7	1	1	14	14
North Eric/L Sahara-5	18	2	43	9	0	0	0	0	40	90	0	0	10	5	30	80	+	1	+	4
North Eric/L Sahara-7	43	23	20	11	0	0	0	0	38	66	0	0	5	17	29	31	+	0	3	18
North Eric/L Sahara-25	59	67	12	13	7	3	6	0	16	17	0	+	10	4	0	6	+	+	5	7
South Eric/L Sahara-8	40	26	25	16	0	0	0	0	35	59	0	0	7	13	27	37	0	0	2	8
South Eric/L Sahara-24	59	58	10	14	3	2	11	1	18	26	0	0	8	8	1	1	+	+	9	16
South Eric/L Sahara-26	63	52	12	20	6	1	4	0	15	27	0	0	10	13	0	7	1	1	4	6
South Eric/L. Sahara-31	49	34	8	37	1	0	0	0	43	29	0	0	34	2	+	13	9	+	+	13
Twin-1	59	57	8	14	4	3	0	0	30	26	0	0	12	5	0	0	1	1	17	21
Twin-11	49	45	11	25	2	+	0	0	39	30	1	1	13	6	2	+	2	1	21	22
Twin-12	62	63	6	10	5	2	0	0	27	25	+	+	4	2	2	+	1	1	19	22
Twin-40	47	30	3	26	1	0	0	0	49	44	+	0	10	10	1	+	8	1	30	32
Twin-45	41	53	10	10	16	13	0	0	33	24	+	+	9	6	4	+	+	+	19	18
Treatment Mean	**50**	**46**	**12**	**17**	**4**	**2**	**2**	**+**	**32**	**36**	**+**	**+**	**10**	**6**	**9**	**12**	**2**	**1**	**11**	**16**

\+ indicates mean values less than 0.5; other values are rounded to the nearest whole number

Table 12. 1999 mean percent cover of principal seeded plants and cheatgrass, Extensive Study main transects

	Crested Wheatgrass			Intermediate/Tall Wheatgrass			Smooth Brome		Russian Wildrye		Basin Wildrye		Alfalfa		Cheat-grass
Chained Treatment	Var[1]	Seed Rate[2]	Mean Cover[3]	Var[1]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Mean Cover[3]
Big Cherry-27	H	4.1	2 (1)	P	3.3	1 (1)	0.0	0	0.0	0	0.0	0	0.4	0	33 (19)
Boutler-2	H	4.6	45 (9)	IP	1.6	+	2.6	+	2.3	0	0.0	0	0.0	0	2 (2)
Boutler-53	H	4.6	12 (1)	IP	1.6	9 (2)	2.6	16 (4)	2.3	4	0.0	0	0.0	0	6 (+)
Center Horse-36	HN	5.2	18 (2)	IP	4.6	12 (4)	0.0	+	0.9	0	0.0	0	0.2	1	6 (5)
East Horse-35	HN	8.5	18 (7)	P	2.9	18 (7)	0.0	0	3.7	+	0.0	0	0.3	+	12 (1)
Eight Mile-9	N	3.0	18 (3)	P	3.0	3 (2)	0.0	0	0.0	+	2.1	0	0.9	1 (1)	6 (1)
Flowell-10	H	8.7	2 (1)	P	2.5	+	0.0	0	0.0	0	0.0	0	1.3	0	3 (2)
Little Sage-30	H	3.3	5 (2)	IT	2.4	6 (2)	0.0	0 (+)	3.3	+ (1)	0.5	+	0.3	2	9 (4)
North Cherry-48	H	4.1	21 (4)	P	3.3	9 (1)	0.0	0	0.0	1 (1)	0.0	+	0.4	0	14 (2)
North Gilson-28	H	3.0	16 (5)	T	2.0	16 (4)	2.0	0	2.0	0	0.0	0	0.0	18 (2)	6 (1)
South Eric/Pole Ck-19	H	3.9	27 (8)		0.0	9 (2)	0.0	0	2.4	+	1.5	+	0.0	0	9 (4)
South Horse-38	H	2.3	9 (2)	IP	5.3	? (6)	0.0	+ (1)	0.0	+	0.0	0	1.1	2 (+)	1 (2)
South Horse-44	H	2.3	2 (8)	IP	5.3	9 (10)	0.0	0	0.0	+	0.0	0	1.1	+ (+)	9 (2)
South Mud-18	HN	5.5	32 (5)	PT	5.6	32 (8)	0.0	0	0.0	0	0.0	0	0.0	+	11 (6)
Tanner Ck-6	HN	5.5	1 (+)	PT	5.5	2	0.0	0	0.0	0	0.0	0	0.0	0	74 (91)
West Horse-37	HN	3.7	1 (1)	IP	3.4	32 (4)	0.0	1	0.0	0	0.0	0	0.2	+	24 (11)
West Horse-47	H	3.7	27 (10)	IP	3.4	0	0.0	0	0.0	0	0.0	0	0.2	2	24 (3)
Treatment Mean		**4.5**	**15 (4)**		**3.3**	**9 (3)**	**0.4**	**1 (+)**	**1.0**	**+ (+)**	**0.2**	**0**	**0.4**	**2 (+)**	**15 (9)**
Aerial-seeded (Non-chained) Treatment															
Baker Cyn/N Horse-39	H	1.4	6	IP	7.0	6 (1)	0.0	0	0.0	0	0.0	0	2.3	+	31 (20)
Baker Cyn/N Horse-43	H	1.4	3 (6)	IP	7.0	18 (4)	0.0	0	0.0	1 (5)	0.0	0	2.3	0 (1)	16 (12)
Big Mud-17	HN	4.8	4 (2)	IPT	6.8	4	0.0	1 (+)	0.3	0	0.0	0	0.0	0	24 (14)
Boutler-3	H	4.6	15 (5)	IP	1.6	15 (3)	2.6	6 (2)	2.3	+	0.0	0	0.0	0	1 (1)
Little Mud-14	N	3.0	12 (3)	PT	5.0	12 (3)	2.3	2 (1)	0.0	0	0.0	0	0.0	0	2 (1)
Middle Mud-16	H	6.2	27 (9)	P	2.0	24 (5)	1.5	6 (2)	0.0	+	0.0	0	1.2	1	2 (1)
North Eric-51	N	5.1	5 (1)	P	3.0	4	0.0	0	2.0	+	0.0	0	0.0	0	21 (20)
North Gilson-29	H	3.0	6	T	2.0	6 (+)	2.0	0	2.0	0	0.0	0	0.0	6 (6)	39 (19)
Sabie-4	N	3.5	18 (4)	PT	5.2	18 (4)	1.6	12 (2)	0.0	0	0.0	0	0.0	0	2 (+)
Sage Valley-50	HN	3.4	2 (1)	I	0.9	2 (1)	0.0	0	3.6	+	1.8	+	0.0	+	38 (20)
Sevier-Sara-49	H	3.3	3 (1)	I	1.7	3 (1)	0.0	0	3.3	+	0.9	0	0.3	+	38 (22)
South Eric/Black Mtn-21	H	3.9	3 (2)		0.0	3 (1)	0.0	0	2.4	2 (+)	1.5	1	0.0	0	21 (9)
South Gilson-41	H	4.0	6 (1)	T	2.0	2 (1)	0.0	0	3.0	+	0.0	0	0.0	0	27 (25)
West Fork-34	HN	3.6	9 (2)	IT	2.5	6 (1)	0.0	0	3.2	+	0.4	+	0.3	+	15 (12)
West Hills-33	HN	5.6	5 (2)	IPT	2.3	2 (1)	0.7	+	0.8	0	0.1	0	1.1	2 (+)	14 (13)
Treatment Mean		**3.8**	**8 (2)**		**3.3**	**8 (2)**	**0.7**	**2 (+)**	**1.4**	**+ (+)**	**0.3**	**+**	**0.5**	**1 (+)**	**19 (13)**
Drilled Treatment															
Leamington-15	H	4.1	12 (3)	I	2.1	2 (1)	0.0	0	2.1	0	0.0	0	0.0	0	16 (6)
Leamington-20	H	4.1	32 (5)	I	2.1	32 (3)	0.0	6 (+)	2.1	1 (2)	0.0	0	0.0	1	2 (1)
Leamington-22	H	4.1	51 (7)	I	2.1	44 (3)	0.0	0	2.1	0	0.0	0	0.0	+	1 (+)
Leamington-32	H	4.1	18 (3)	I	2.1	24 (2)	0.0	0	2.1	+	0.0	0	0.0	0	6 (3)
N Eric/L Sahara-5	H	3.0	3 (+)	T	2.0	+	0.0	0	3.0	0	0.0	0	0.0	0	69 (94)
N Eric/L Sahara-7	H	3.0	2 (3)	T	2.0	2 (+)	0.0	0	3.0	0	0.0	0	0.0	0	33 (31)
N Eric/L Sahara-25	H	3.0	12 (4)	T	2.0	9 (1)	0.0	0	3.0	2 (1)	0.0	0	0.0	+	18 (34)
S Eric/L Sahara-8	H	3.0	2 (5)		0.0	4	0.0	0	3.0	0	0.0	0	1.0	+ (2)	51 (1)
S Eric/L Sahara-24	H	3.0	27 (2)		0.0	18 (2)	0.0	0	3.0	3 (6)	0.0	0	1.0	16	3 (2)
S Eric/L Sahara-26	H	3.0	2 (2)		0.0	1	0.0	0	3.0	+	0.0	0	1.0	2 (1)	6 (1)
S. Eric/L. Sahara-31	H	3.0	1 (+)		0.0	24 (4)	0.0	0	3.0	+	0.0	0	1.0	+	24 (11)
Twin-1	H	2.2	27 (3)	IP	4.4	32 (6)	0.0	5 (+)	0.0	+	0.0	0	1.2	6 (1)	+
Twin-11	H	2.2	7 (4)	IP	4.4	11 (11)	0.0	+ (2)	0.0	0	0.0	0	1.2	6 (5)	1
Twin-12	H	2.2	9 (6)	IP	4.4	21 (10)	0.0	+	0.0	0	0.0	0	1.2	2 (1)	+
Twin-40	H	2.2	29 (15)	IP	4.4	38 (15)	0.0	+ (+)	0.0	1	0.0	0	1.2	2 (1)	+
Twin-45	H	2.2	12 (5)	IP	4.4	27 (8)	0.0	+	0.0	0	0.0	0	1.2	9 (2)	1
Treatment Mean		**3.0**	**15 (4)**		**2.3**	**18 (4)**	**0.0**	**1 (+)**	**1.8**	**1 (1)**	**0.0**	**0**	**0.6**	**3 (1)**	**14 (11)**

[1] wheatgrass varieties in seed mix; H=Hycrest crested, N=Nordan crested, I=Intermediate, P=Pubescent, T=Tall

[2] seeding rate in lbs./acre

[3] value on left is 1999 mean percent cover of 100m² plots; value in parentheses is 1999 mean percent cover of 3x3 ft. plots, if greater than zero

Table 13. 1999 mean percent cover (100m^2 plots) of miscellaneous important plants (Extensive Study transects: chained, aerial-seeded, and drilled)

		Seeded			Native Grasses									Native Forbs and Shrubs									Exotic Forbs					
		Atriplex canescens	Kochia prostrata	Sanguisorba minor	Agropyron smithii	Agropyron spicatum	Agropyron trachycaulum	Hilaria jamesii	Oryzopsis hymenoides	Poa spp.	Sitanion hystrix	Sporobolus cryptandrus	Stipa comata	Artemisia tridentata	Astragalus spp.	Chrysothamnus nauseosus	Gutierrezia sarothrae	Phlox spp.	Quercus gambelii	Sarcobatus vermiculatus	Sphaeralcea spp.	Vicia americana	Alyssum desertorum	Descurainia sophia	Lactuca serriola	Salsola pestifer	Sisymbrium altissimum	Tragopogon dubius
Chained Treatment	Big Cherry-27						15	+	2		+	+	1	2	+		5				+		+		+	+	+	+
	Boutler-2								2					+				+					2		3	+	+	
	Boutler-53					5	4		2	1	+			+			+					+	1	+	1			
	Center Horse-36		+		+	+			1	+	3						+	1				1	1		+		1	1
	East Horse-35				4	+			+	+	1						+					6	1		+			+
	Eight Mile-9					24					+			+	2		1		5				1	+	+		+	+
	Flowell-10																				+				+	12	21	+
	Little Sage-30	+		+		2	1	5	1	+	2		24	+	+	+	+	+					+		+		+	+
	North Cherry-48								+	+	1							1				+	14		+			
	North Gilson-28					2	4		+	+	1				+						1	+	+		+		+	+
	South Eric/Pole Ck-19	1					9		+	+	+		+	1		+	+				1	1	1		1			+
	South Horse-38			+	10	18	29		+	+	+				+			2			+	1			+			
	South Horse-44									1	2												+		+	6	+	1
	South Mud-18										+										1							+
	Tanner Ck-6																			6				1			+	
	West Horse-37		+	+							+																+	+
	West Horse-47					1	27	+	+	1	1		+					+				+			+		+	
Aerial-seeded Treatment	Baker Cyn/N Horse-39			+	1	5		2	9	+	9		+		4		1	2				1	+		1		+	+
	Baker Cyn/N Horse-43					17			+	1	+			+	+		+	1				+	12		+	+	1	
	Big Mud-17		9			24			1	1	5		+	+			+				+		+	1	+		+	+
	Boutler-3								1	1	+										+		1		1			
	Little Mud-14					+	8		1	+	+			+	+	+		2				+	2	+	1			+
	Middle Mud-16					1			2	+	+							+				1	1	+	+		1	+
	North Eric-51					23		+	6	+	18		10	+	+		+	5					5	1	+		+	1
	North Gilson-29	+				1	4		+		+			+	1		+					+		+	1		1	1
	Sabie-4					2	1		2	+	2				+		+	2				+	2	+	1		+	
	Sage Valley-50			1		6	1		2		6		+		3	+	4	1					2	+	+		+	1
	Sevier-Sara-49			+	+					1				1		+						+	+	+	1	+	1	+
	South Eric/Black Mtn-21								+												+			+	1	+	+	
	South Gilson-41					1			+	+	1				1		2	1					1	+	1		1	+
	West Fork-34			1		20			1		1				+	+	1	2				+	1		+			+
	West Hills-33					12			+	+	1				5	+		2					+		2		1	1
Drilled Treatment	Leamington-15								+		2			+							1		+	2	+		+	+
	Leamington-20	+							+		+			+						+	+		+	+	+			+
	Leamington-22										+				+			+			1		+		+			
	Leamington-32								+	+	+	6		+			+					+	2		+		+	
	North Eric/L Sahara-5										+		+											9	+		1	
	North Eric/L Sahara-7																				+			1			38	
	North Eric/L Sahara-25			+					+		+	+			+			+			1			+	1	3	1	+
	South Eric/L Sahara-8										+										+			1			38	
	South Eric/L Sahara-24								+	+	+										2			+	+	+	+	+
	South Eric/L Sahara-26			+							1							+			1			+	2	18	+	+
	South Eric/L Sahara-31										+													+	+	2	+	+
	Twin-1			1							+										2				+			
	Twin-11		1	1	1					1	+			1	1						+		+		+			+
	Twin-12		+	+							2										1						+	
	Twin-40			+	9	+																9	1		+			+
	Twin-45		+	2						+	1																	

+ indicates mean values less than 0.5; other values are rounded to the nearest whole number and zero values are not shown

Table 14. Density of seeded plants (total counted in four 3x3ft plots[1]) by year, Extensive Study main transects

	Seeded Shrubs		Seeded Forbs		Seeded Grasses					
	1997	1999	1997	1999	1997	1999	1999	1999	1999	1999
	Total	Prostrate Kochia	Total	Alfalfa	Total	Total	Crested Wheatgr.	Inter./Tall Wheatgr.	Smooth Brome	Russian Wildrye
Chained Treatment										
Big Cherry-27	0	0	0	0	3	6	4	2	0	0
Boutler-2	0	0	0	0	12	18	18	0	0	0
Boutler-53	0	0	0	0	5	32	5	4	23	0
Center Horse-36	0	0	0	0	33	24	8	16	0	0
East Horse-35	0	0	0	0	44	32	13	19	0	0
Eight Mile-9	0	0	1	4	10	13	9	4	0	0
Flowell-10	0	0	0	0	0	12	12	0	0	0
Little Sage-30	0	0	0	0	12	8	4	2	1	1
North Cherry-48	0	0	0	0	33	26	22	3	0	1
North Gilson-28	0	0	28	11	64	37	23	14	0	0
S Eric/Pole Ck-19	0	0	0	0	70	44	33	11	0	0
South Horse-38	0	0	2	2	35	16	1	14	1	0
South Horse-44	0	0	1	1	28	23	10	13	0	0
South Mud-18	0	0	0	0	89	46	23	23	0	0
Tanner Ck-6	0	0	0	0	0	1	1	0	0	0
West Horse-37	1	1	0	0	5	5	1	4	0	0
West Horse-47	0	0	1	0	59	15	15	0	0	0
Treatment Mean	**0.06**	**0.06**	**1.94**	**1.06**	**29.53**	**21.06**	**11.88**	**7.59**	**1.47**	**0.12**
Aerial-seeded (Non-chained) Treatment										
Baker Cyn/N Horse-39	0	0	0	0	2	1	0	1	0	0
Baker Cyn/N Horse-43	0	0	0	1	9	20	8	8	0	4
Big Mud-17	2	2	0	0	5	9	7	0	2	0
Boutler-3	0	0	10	0	90	54	39	6	9	0
Little Mud-14	1	0	0	0	17	28	13	8	7	0
Middle Mud-16	0	0	2	0	28	112	46	51	15	0
North Eric-51	0	0	0	0	0	4	4	0	0	0
North Gilson-29	0	0	18	110	2	1	0	1	0	0
Sabie-4	1	0	29	0	185	49	18	15	16	0
Sage Valley-50	0	0	0	0	3	5	3	2	0	0
Sevier-Sara-49	1	0	0	0	1	8	4	4	0	0
S Eric/Black Mtn-21	0	0	0	0	1	8	6	1	0	1
South Gilson-41	0	0	0	0	11	11	8	3	0	0
West Fork-34	0	0	0	0	7	9	7	2	0	0
West Hills-33	0	0	2	1	9	10	9	1	0	0
Treatment Mean	**0.33**	**0.14**	**4.06**	**7.47**	**24.66**	**21.93**	**11.46**	**6.87**	**3.26**	**0.33**
Drilled Treatment										
Leamington-15	0	0	0	0	19	13	9	4	0	0
Leamington-20	0	0	0	0	34	31	19	8	1	3
Leamington-22	0	0	0	0	113	50	37	13	0	0
Leamington-32	0	0	0	0	31	17	12	5	0	0
N Eric/L Sahara-5	0	0	1	0	2	2	2	0	0	0
N Eric/L Sahara-7	0	0	0	0	3	8	7	1	0	0
N Eric/L Sahara-25	0	0	0	0	3	5	3	1	0	1
S Eric/L Sahara-8	0	0	25	0	93	12	10	2	0	0
S Eric/L Sahara-24	0	0	6	2	4	9	6	0	0	3
S Eric/L Sahara-26	0	0	1	1	0	8	8	0	0	0
S. Eric/L. Sahara-31	0	0	95	0	5	50	1	49	0	0
Twin-1	0	0	18	4	81	32	9	22	1	0
Twin-11	0	0	44	19	252	72	25	41	6	0
Twin-12	0	0	1	1	41	27	9	18	0	0
Twin-40	0	0	10	5	108	56	28	26	2	0
Twin-45	1	0	7	5	40	28	11	17	0	0
Treatment Mean	**0.06**	**0.00**	**13.00**	**2.38**	**51.81**	**26.25**	**12.25**	**12.94**	**0.63**	**0.44**

[1] four plots of 3 ft x 3 ft =36 ft^2 =3.348 m^2

Table 15. 1997 and 1999 mean percent cover ($100m^2$ plots) by category (Extensive Study drilled/non-seeded paired transects)

	Bare Soil		Litter		Rock >1cm		Crypto-gams		Vascular Plants		Shrubs & Trees		Forbs		Exotic Grasses		Native Grasses		Seeded Grasses	
	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999	1997	1999
Leamington-22 (drilled)	59	66	10	11	7	3	0	0	25	20	0	+	5	+	3	+	+	+	16	19
Leamington-23 (non-seeded)	65	60	9	8	5	1	6	0	15	32	0	+	8	1	6	29	+	1	+	+
Twin-12 (drilled)	62	63	6	10	5	2	0	0	27	25	+	+	4	2	2	+	1	1	19	22
Twin-13 (non-seeded)	66	35	11	6	6	3	0	0	17	56	0	0	5	2	11	54	1	1	0	0
Twin-40 (drilled)	47	30	3	26	1	0	0	0	49	44	+	0	10	10	1	+	8	1	30	32
Twin-42 (non-seeded)	63	51	5	13	11	1	0	0	22	35	0	0	12	9	2	17	8	10	+	+
Twin-45 (drilled)	41	53	10	10	16	13	0	0	33	24	+	+	9	6	4	+	+	+	19	18
Twin-46 (non-seeded)	38	14	11	50	10	2	0	0	41	35	0	0	11	2	29	33	+	0	1	+

+ indicates mean values less than 0.5; other values are rounded to the nearest whole number

Table 16. 1999 mean percent cover of principal seeded plants and cheatgrass (Extensive Study drilled/non-seeded paired transects)

	Crested Wheatgrass			Intermediate/Tall Wheatgrass			Smooth Brome		Russian Wildrye		Basin Wildrye		Alfalfa		Cheat-grass
	Var[1]	Seed Rate[2]	Mean Cover[3]	Var[1]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Seed Rate[2]	Mean Cover[3]	Mean Cover[3]
Leamington-22 (drilled)	H	4.1	51 (7)	I	2.1	44 (3)	0.0	0	2.1	0	0.0	0	0.0	+	1 (+)
Leamington-23 (non-seeded)		0.0	+		0.0	+	0.0	0	0.0	+	0.0	0	0.0	0	63 (25)
Twin-12 (drilled)	H	2.2	9 (6)	IP	4.4	21 (10)	0.0	+	0.0	0	0.0	0	1.2	2 (1)	+
Twin-13 (non-seeded)		0.0	0		0.0	+	0.0	0	0.0	0	0.0	0	0.0	0	85 (22)
Twin-40 (drilled)	H	2.2	29 (15)	IP	4.4	38 (15)	0.0	+ (+)	0.0	1	0.0	0	1.2	2 (1)	+
Twin-42 (non-seeded)		0.0	+		0.0	+	0.0	0	0.0	+	0.0	0	0.0	0	39 (24)
Twin-45 (drilled)	H	2.2	12 (5)	IP	4.4	27 (8)	0.0	+	0.0	0	0.0	0	1.2	9 (2)	1
Twin-46 (non-seeded)		0.0	0		0.0	+	0.0	+	0.0	0	0.0	0	0.0	+	80 (25)

[1] wheatgrass varieties in seed mix; H=Hycrest crested, N=Nordan crested, I=Intermediate, P=Pubescent, T=Tall
[2] seeding rate in lbs./acre
[3] value on left is 1999 mean percent cover of $100m^2$ plots; value in parentheses is 1999 mean percent cover of 3x3 ft. plots, if greater than zero
+ indicates mean values less than 0.5; other values are rounded to nearest whole number

Figure 1. Location of Intensive Study Sites (red) and Extensive Study Sites (blue) relative to 1996 fires (shading) in west-central Utah

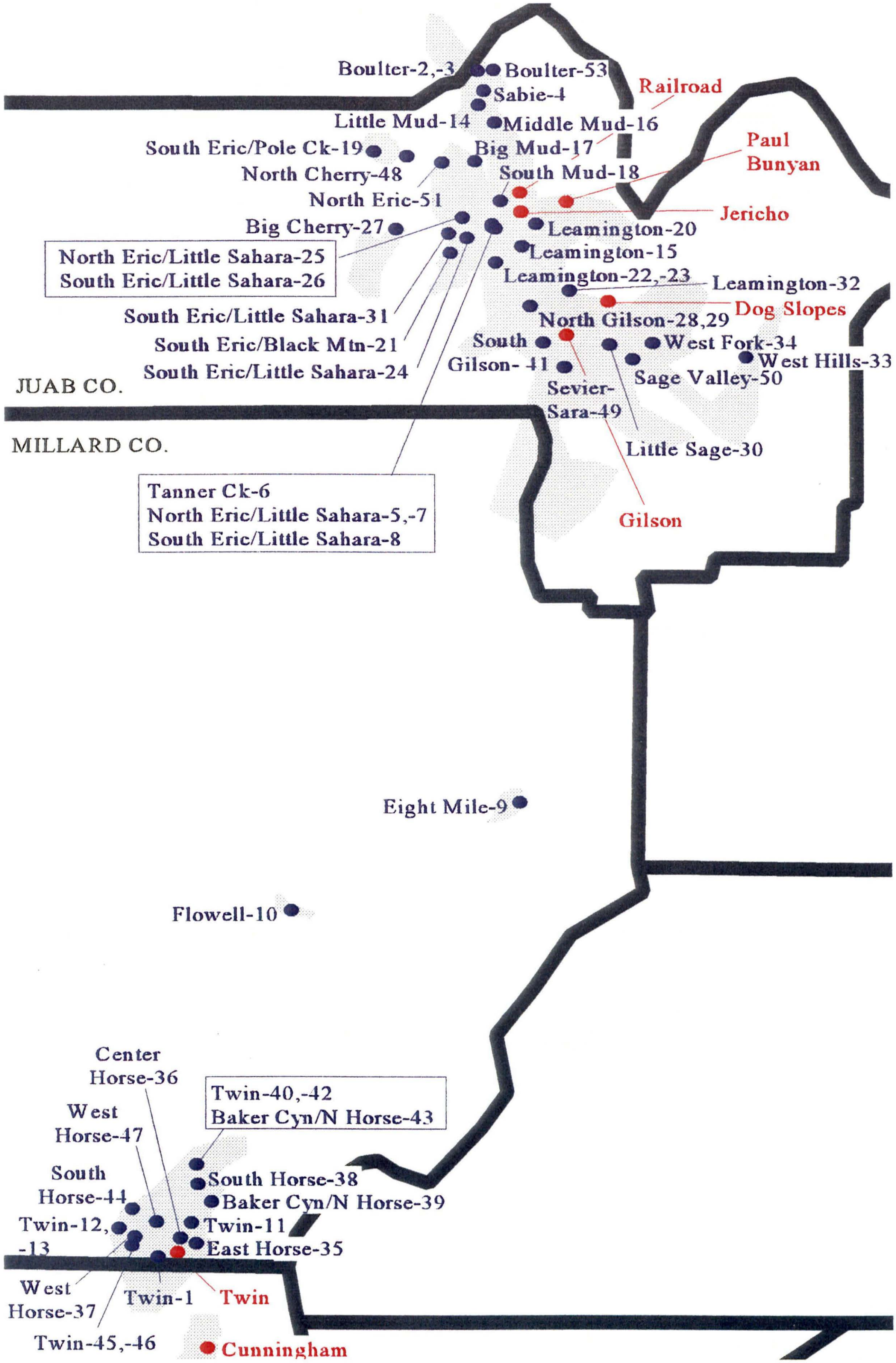
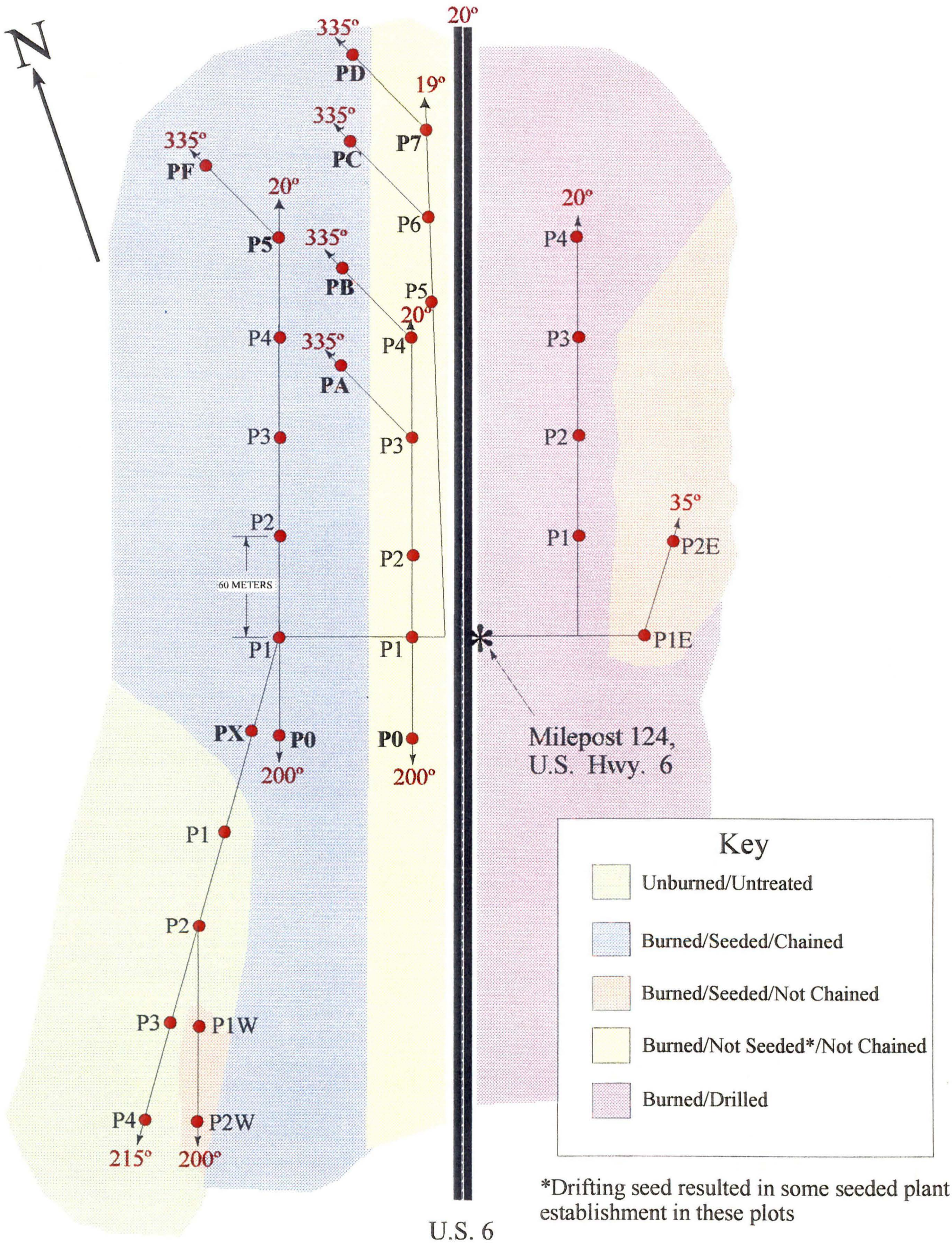
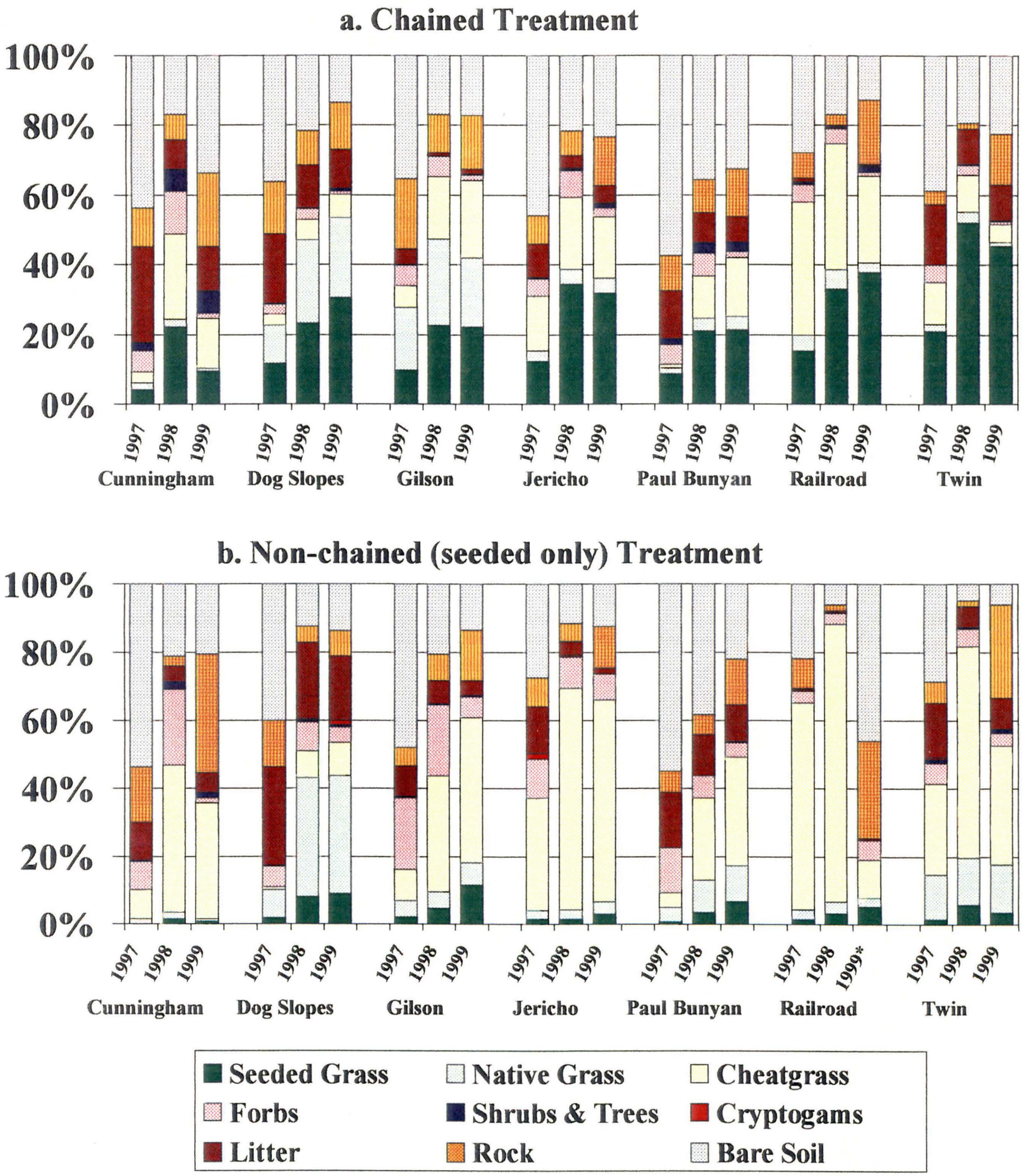


Figure 2. Schematic Map of Jericho Study Site, showing plots placed in 1998 (boldface)



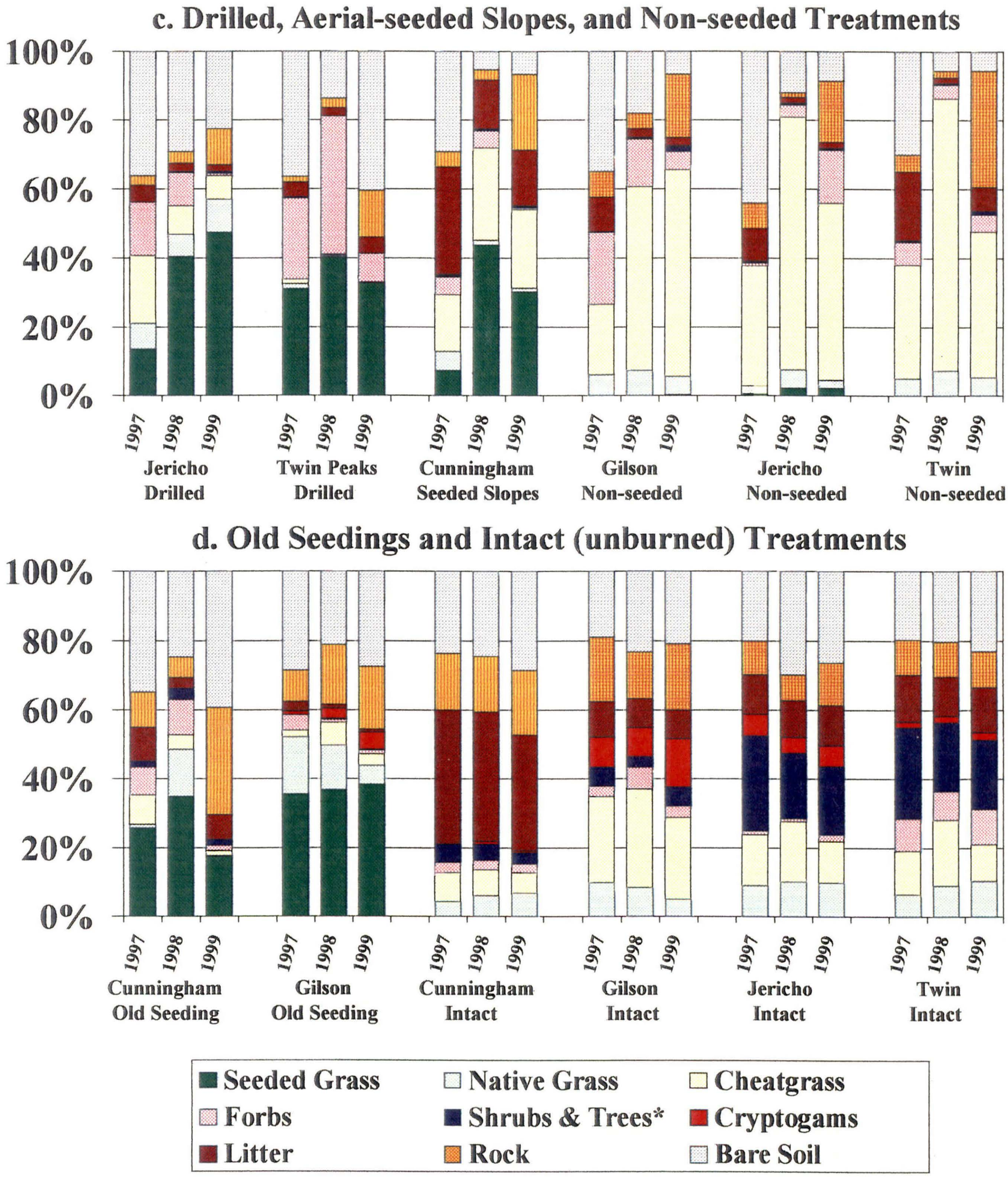
Note: Nearly all plots west of U.S. Highway 6 were burned by the 1999 "Railroad" fire.

Figure 3 (a-b). Mean percent cover of categories by treatment, site, and year, based on $100m^2$ plots of Intensive Study (see Table 3)



*Railroad "non-chained" became a chained treatment following rehabilitation between 1998 and 1999

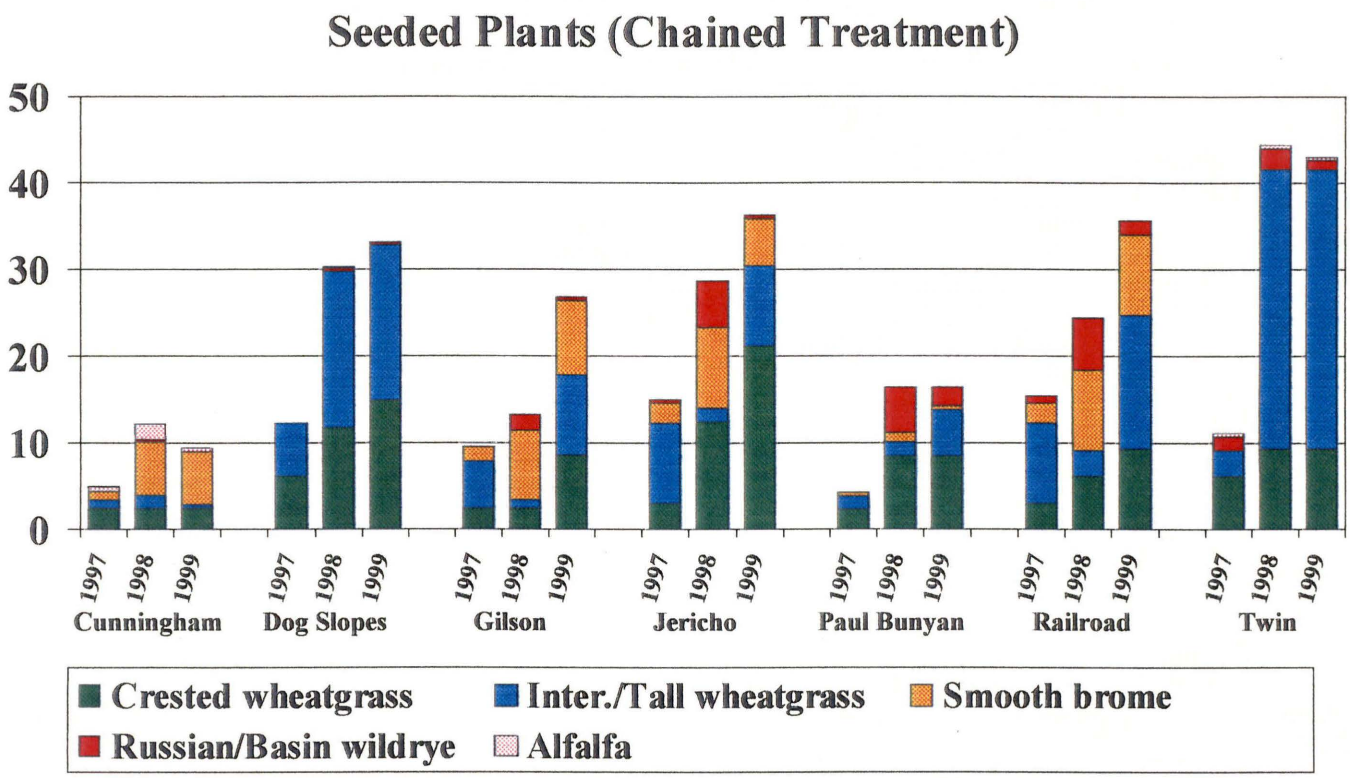
Figure 3 (c-d). Mean percent cover of categories by treatment, site, and year, based on $100m^2$ plots of Intensive Study (see Table 3)



*Includes only trees ca. 1 meter tall or less

Figure 4 (a). Mean percent cover of important plants by treatment, site, and year, based on 100m² plots of Intensive Study (see Tables 4-5)

a. Chained Treatment



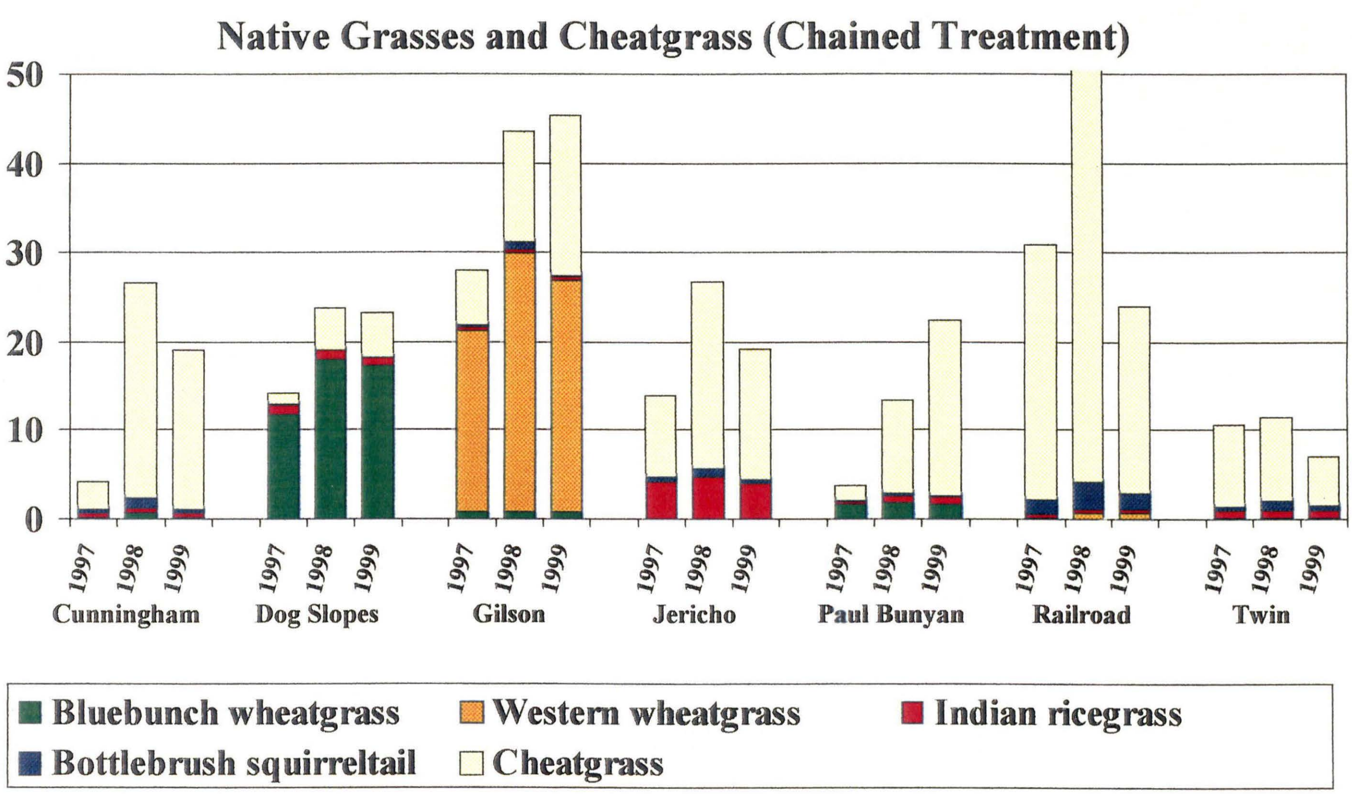
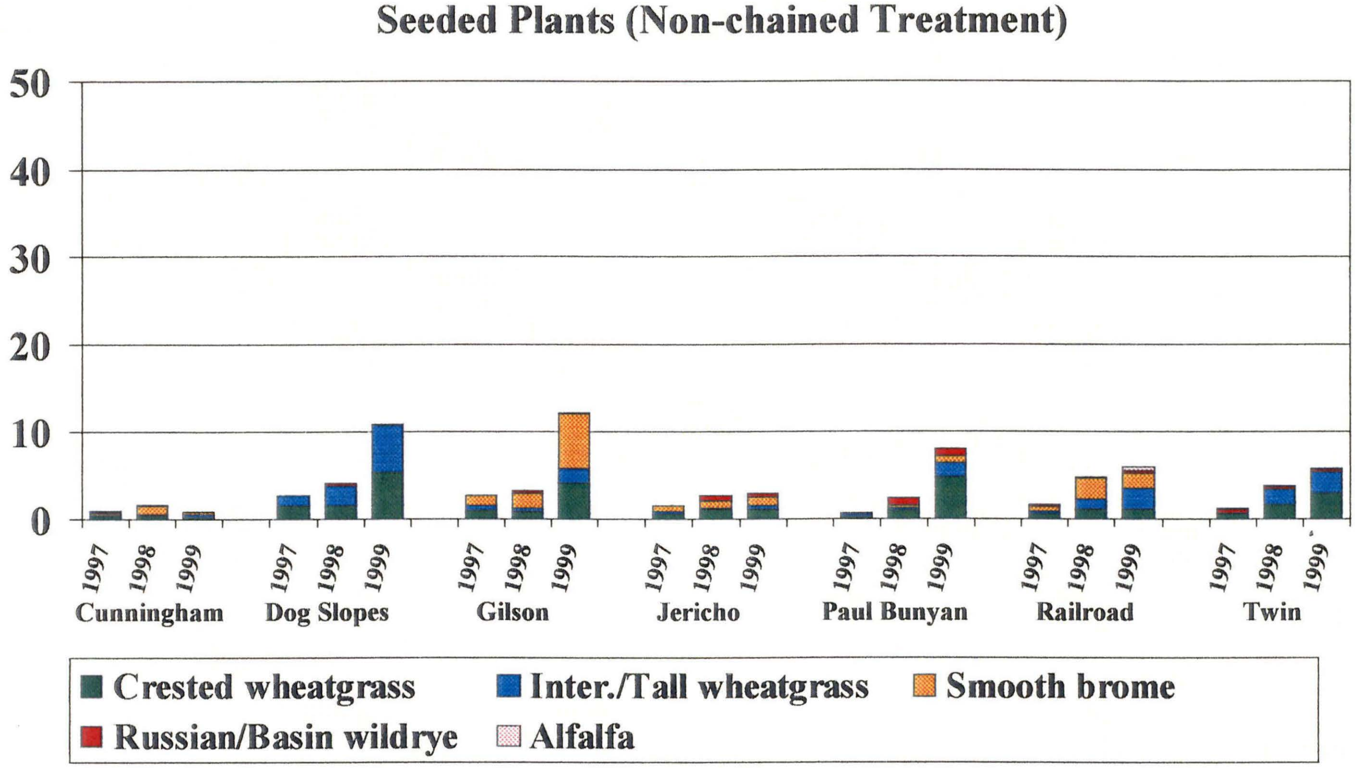


Figure 4 (b). Mean percent cover of important plants by treatment, site, and year, based on 100m^2 plots of Intensive Study (see Tables 4-5)

b. Non-chained (seeded only) Treatment



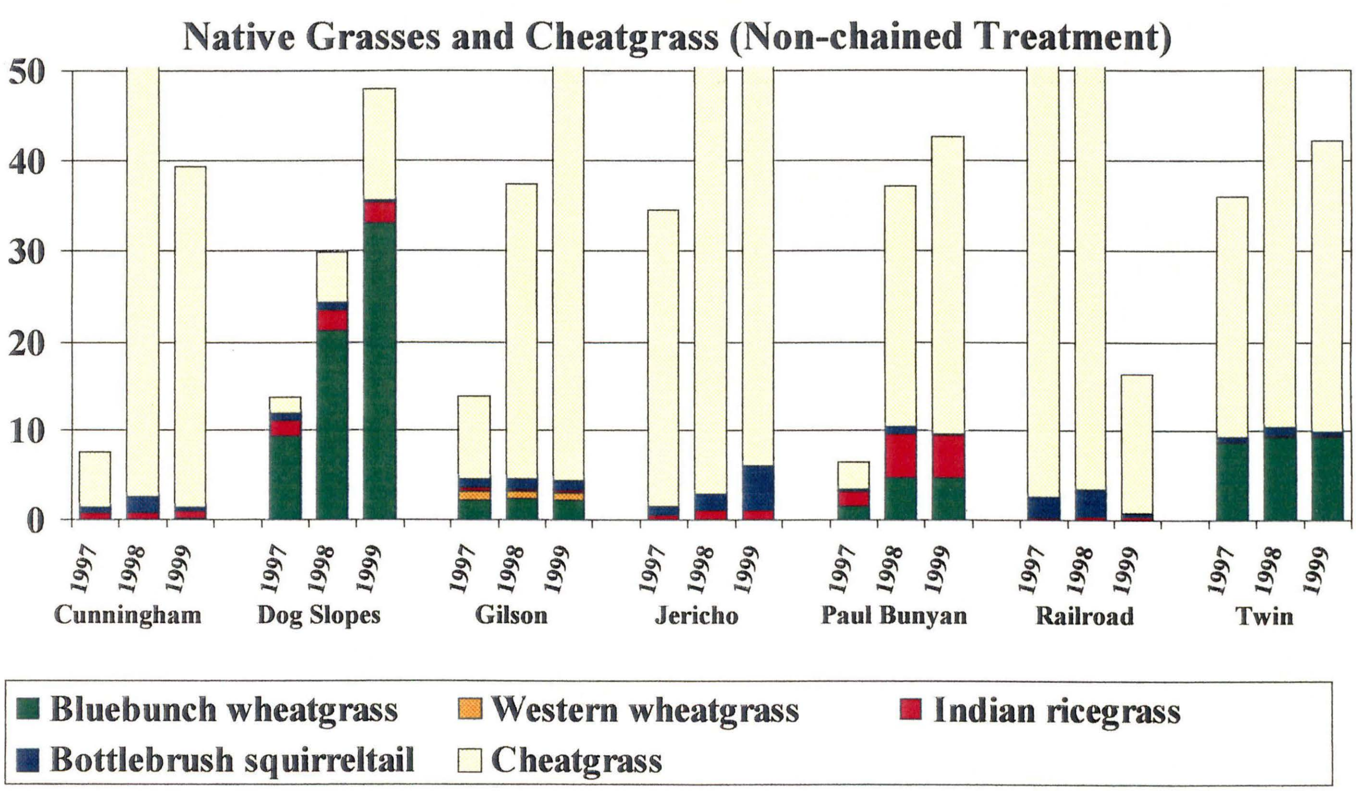
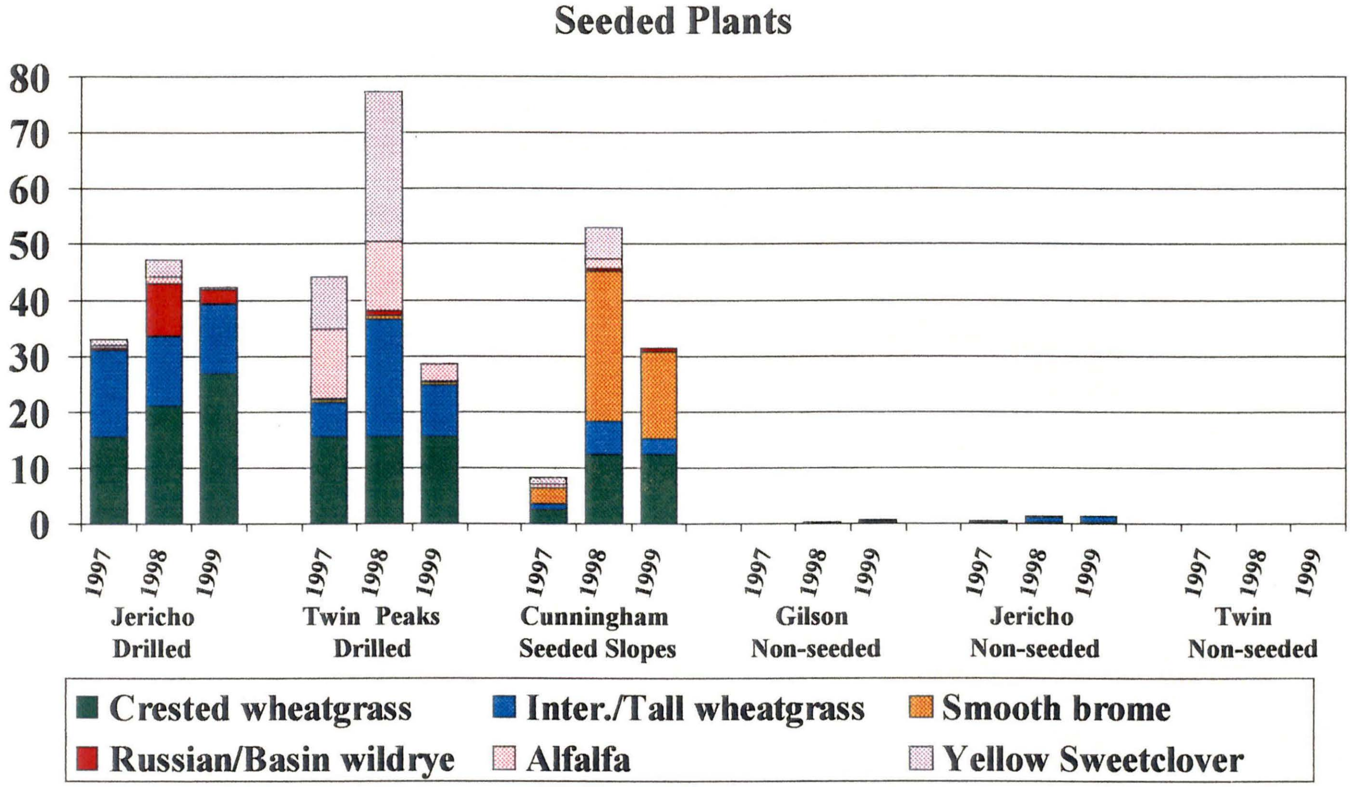
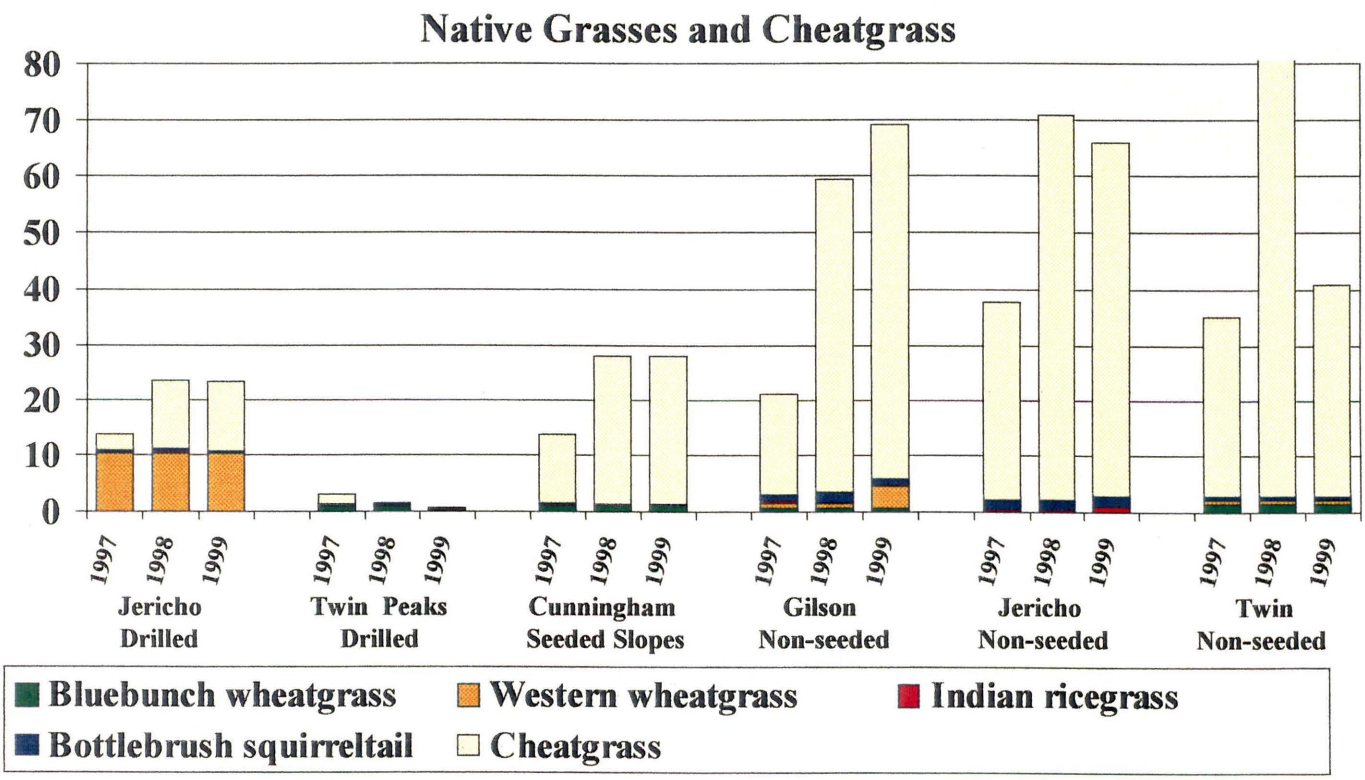


Figure 4 (c). Mean percent cover of important plants by treatment, site, and year, based on 100m^2 plots of Intensive Study (see Tables 4-5)

c. Drilled, Seeded Slopes, and Non-seeded Treatments





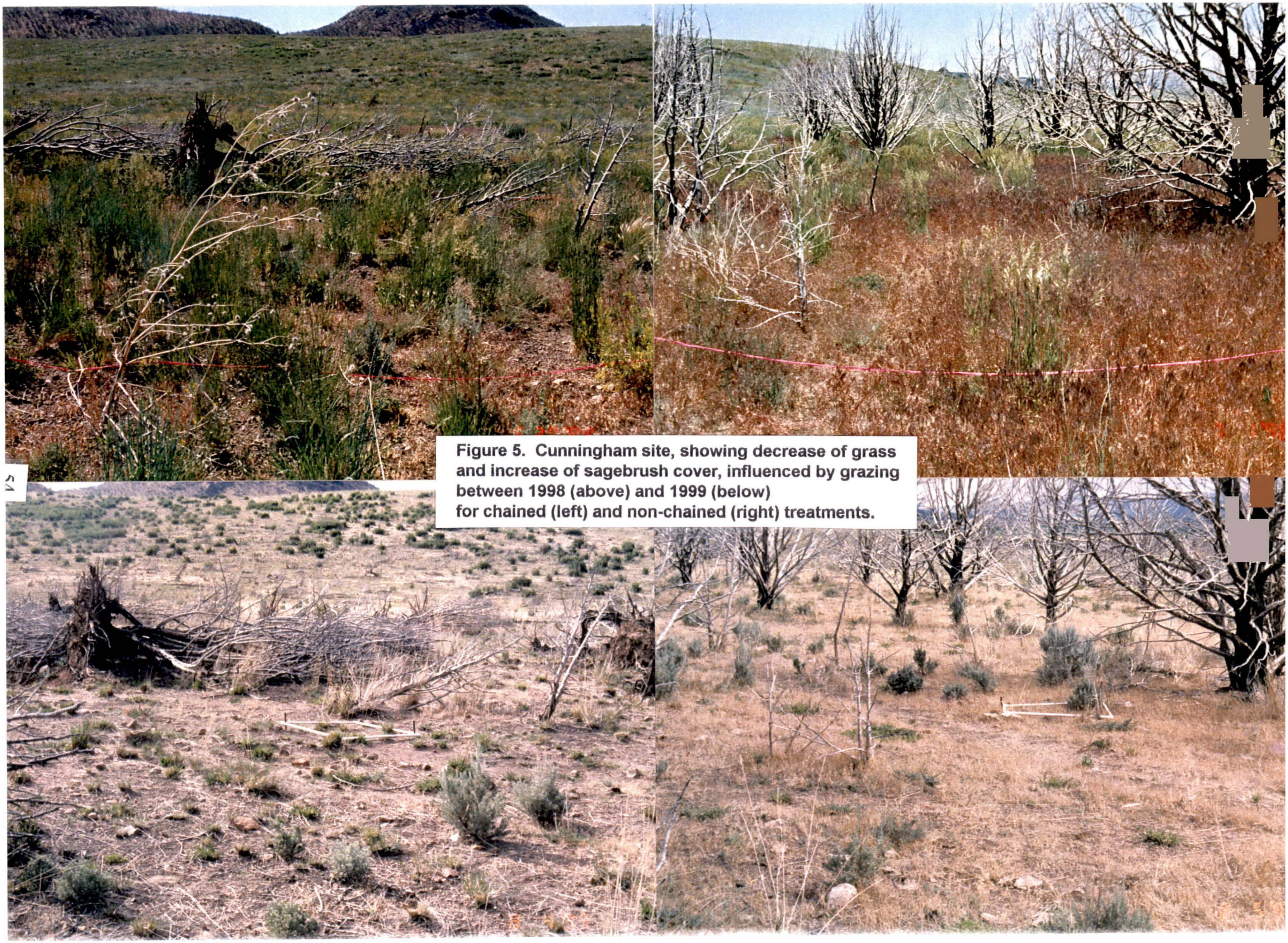


Figure 5. Cunningham site, showing decrease of grass and increase of sagebrush cover, influenced by grazing between 1998 (above) and 1999 (below) for chained (left) and non-chained (right) treatments.

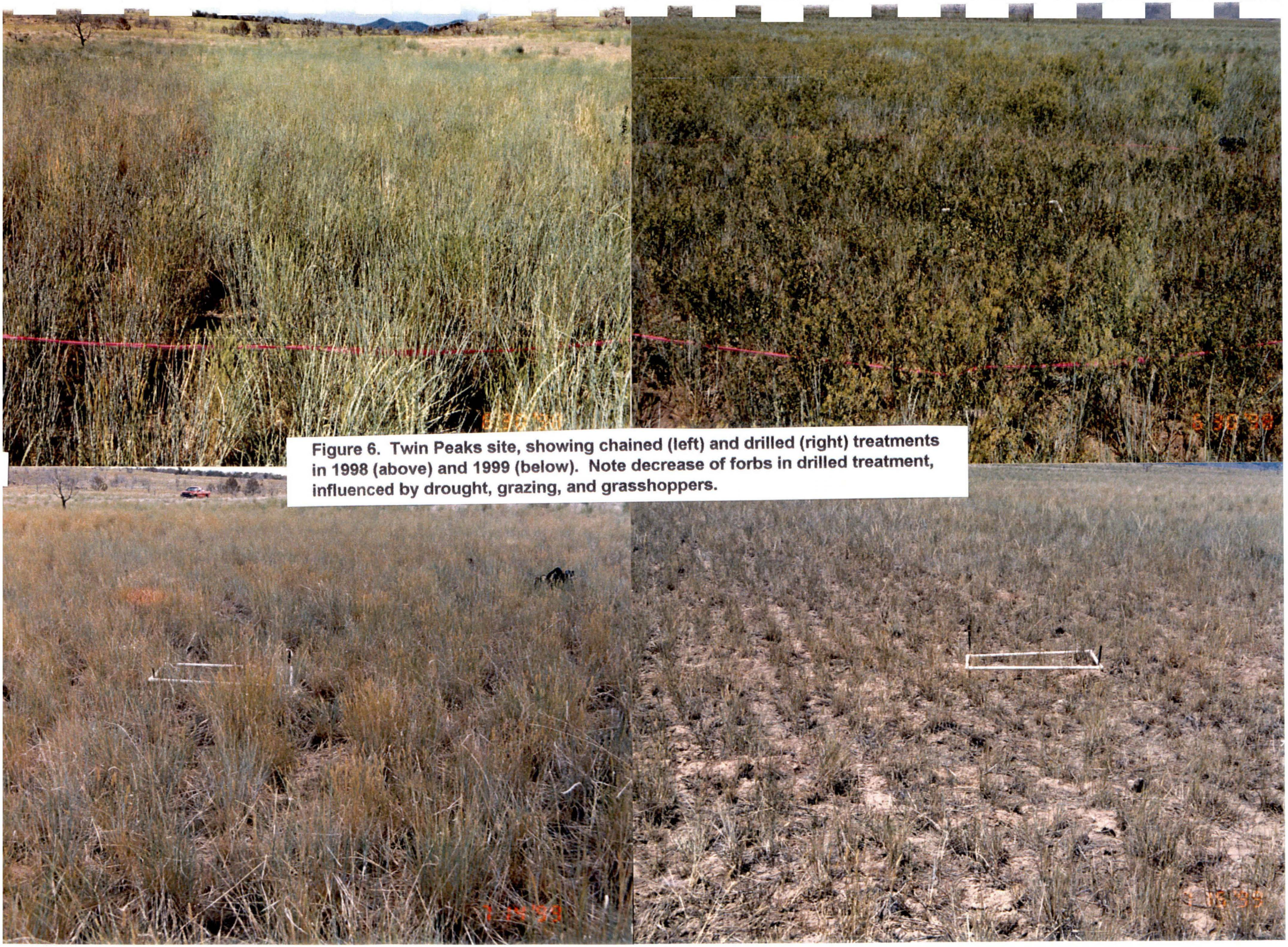


Figure 6. Twin Peaks site, showing chained (left) and drilled (right) treatments in 1998 (above) and 1999 (below). Note decrease of forbs in drilled treatment, influenced by drought, grazing, and grasshoppers.

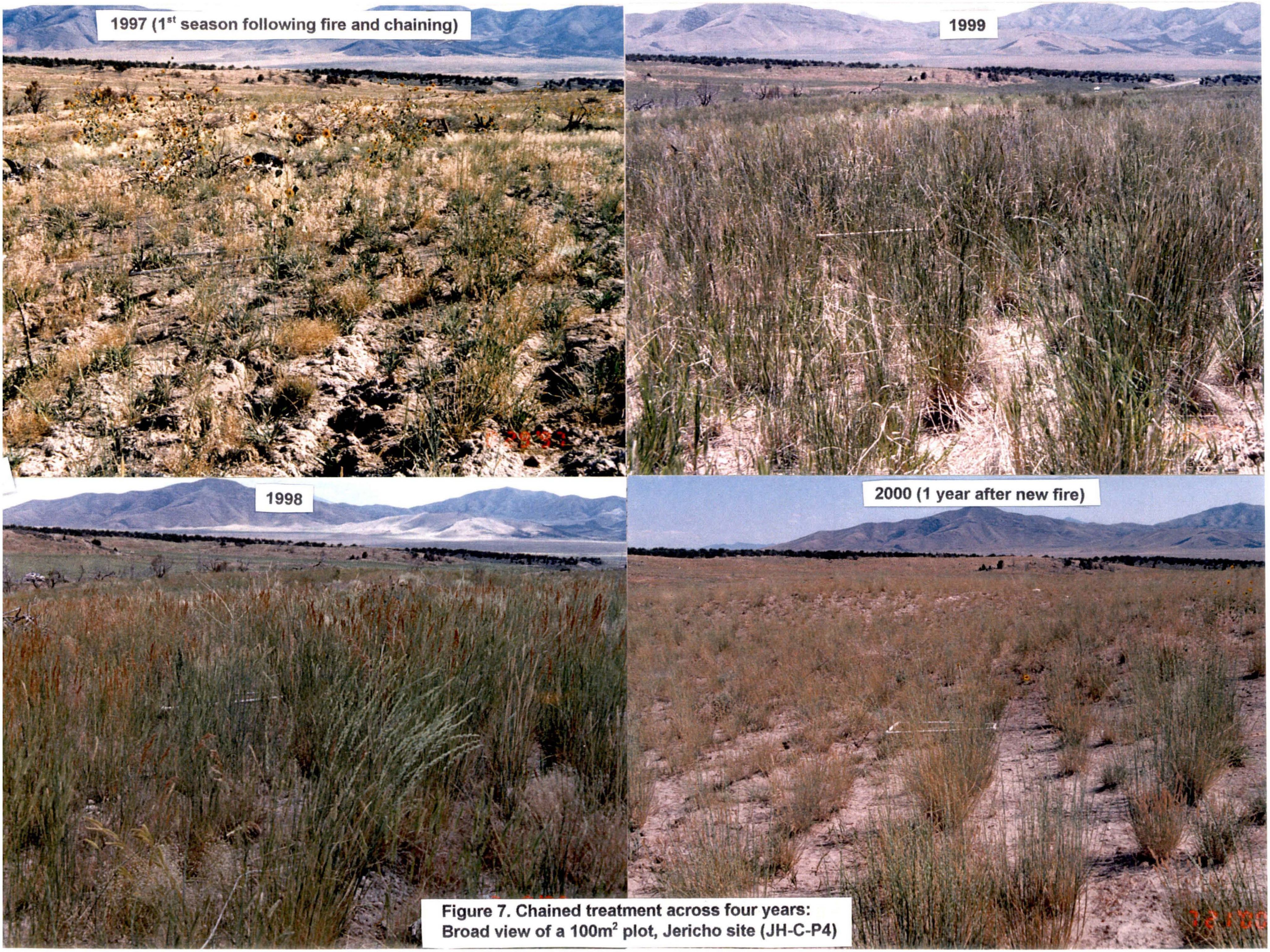


Figure 7. Chained treatment across four years: Broad view of a 100m² plot, Jericho site (JH-C-P4)

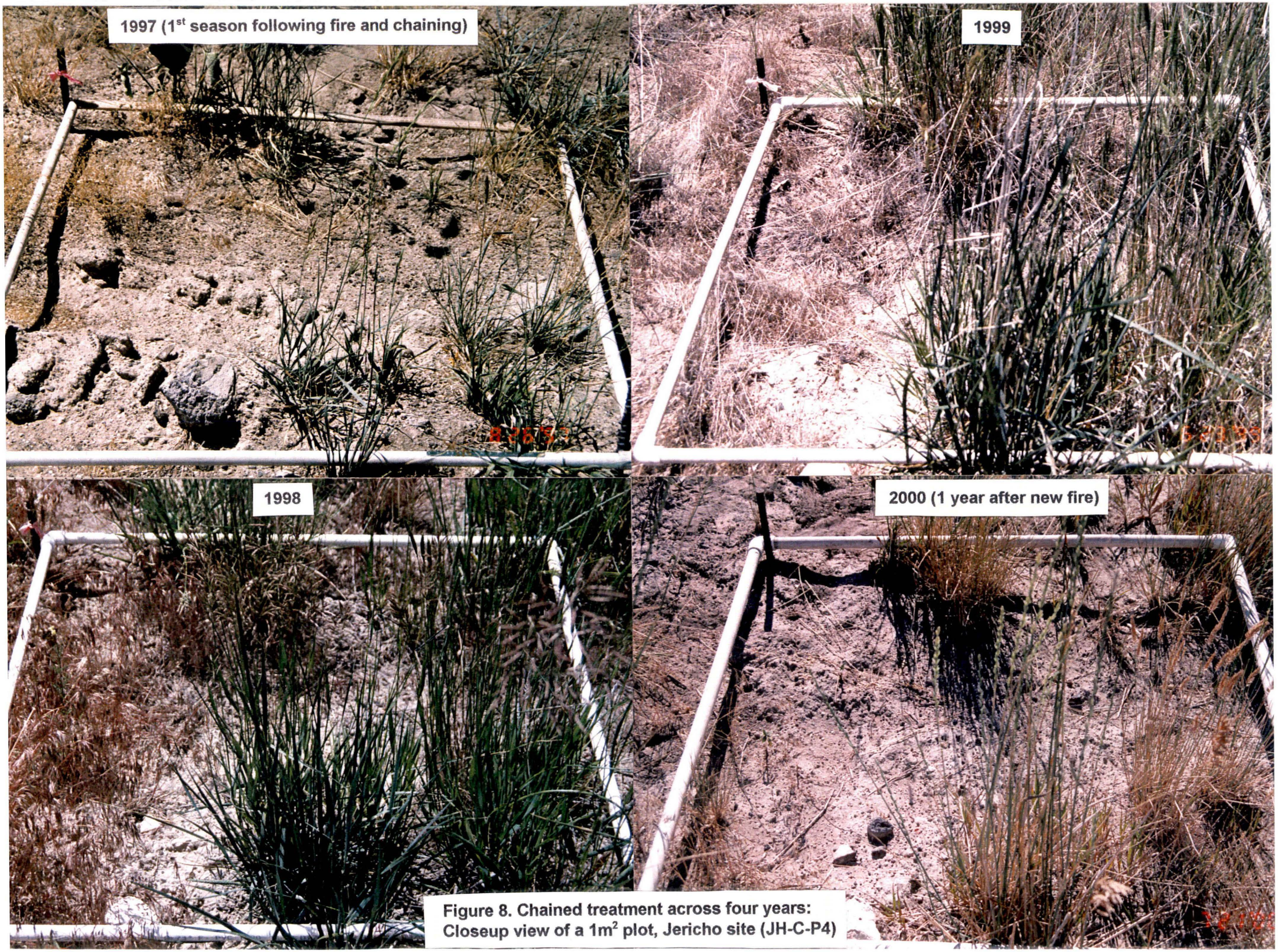


Figure 8. Chained treatment across four years:
Closeup view of a 1m^2 plot, Jericho site (JH-C-P4)

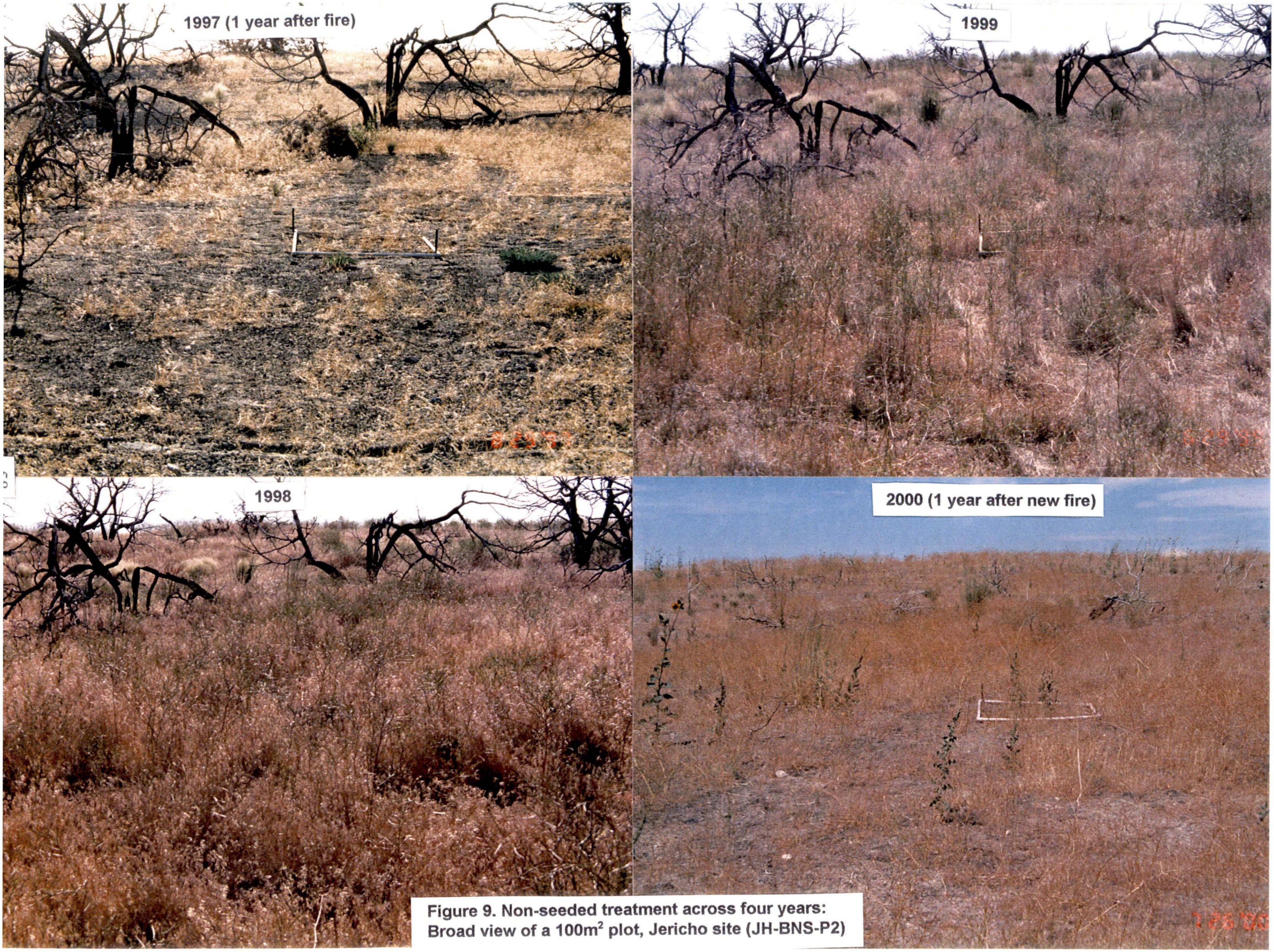


Figure 9. Non-seeded treatment across four years: Broad view of a $100m^2$ plot, Jericho site (JH-BNS-P2)

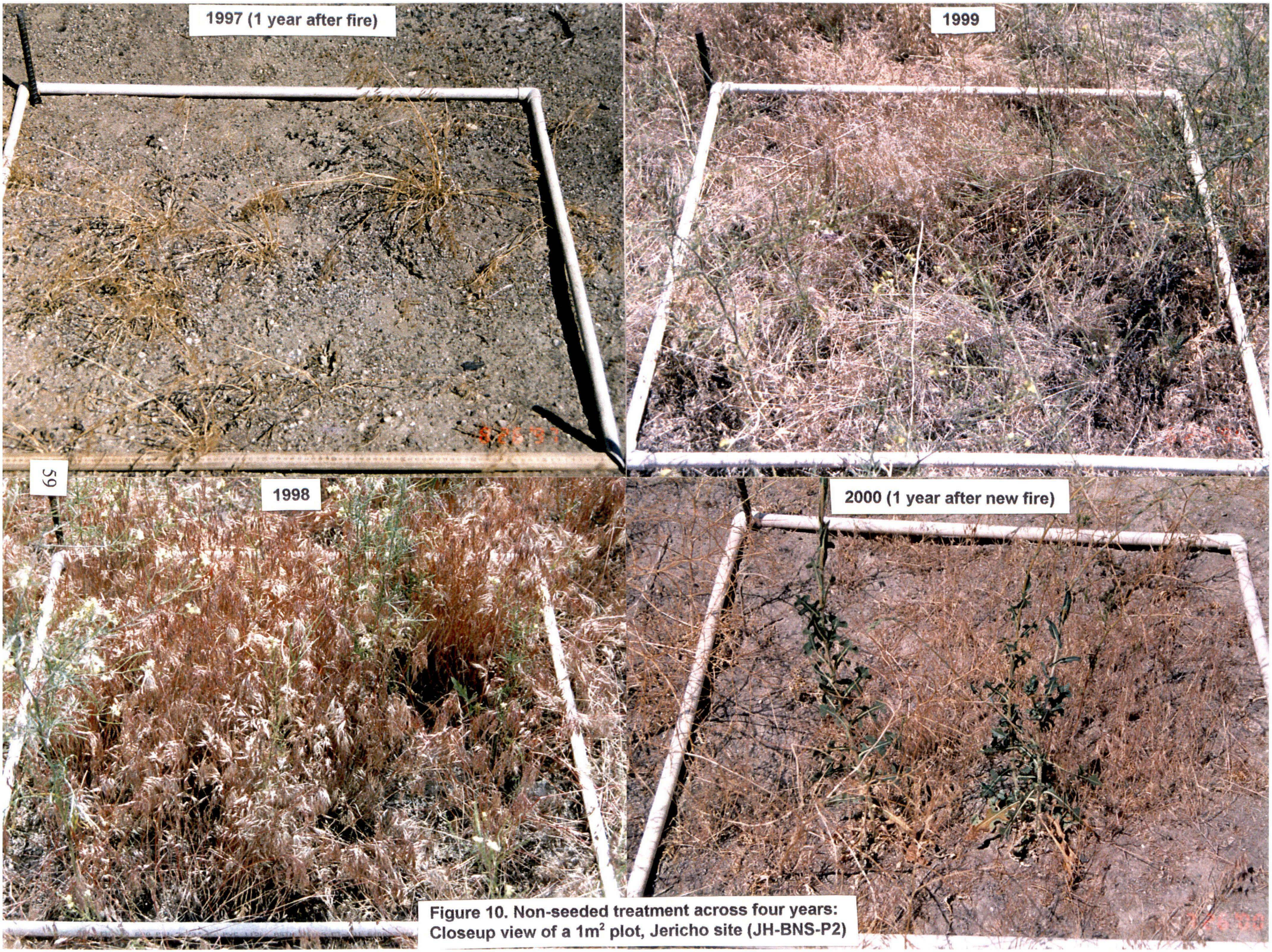


Figure 10. Non-seeded treatment across four years: Closeup view of a 1m^2 plot, Jericho site (JH-BNS-P2)

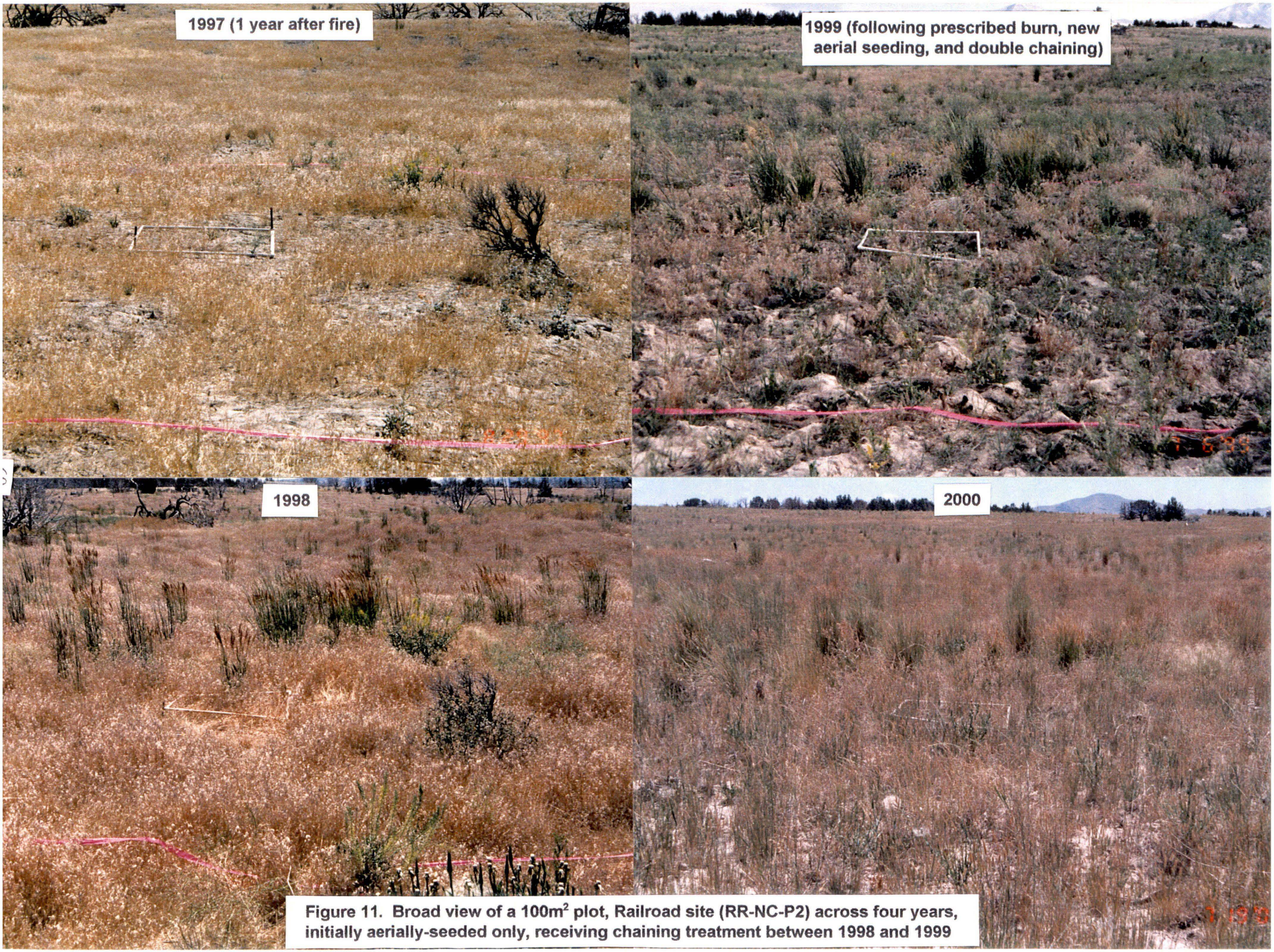


Figure 11. Broad view of a 100m^2 plot, Railroad site (RR-NC-P2) across four years, initially aerially-seeded only, receiving chaining treatment between 1998 and 1999

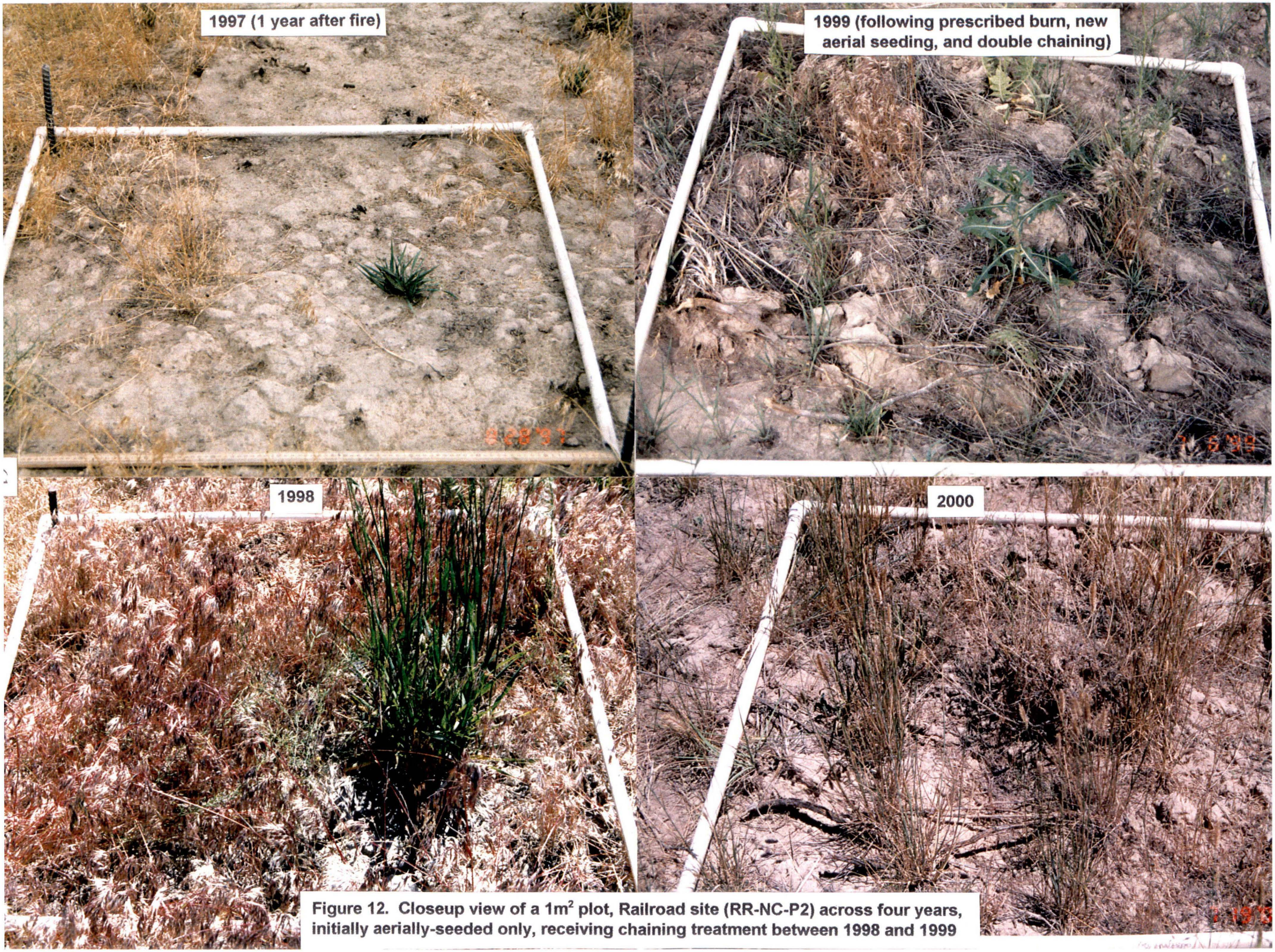


Figure 12. Closeup view of a $1m^2$ plot, Railroad site (RR-NC-P2) across four years, initially aerially-seeded only, receiving chaining treatment between 1998 and 1999

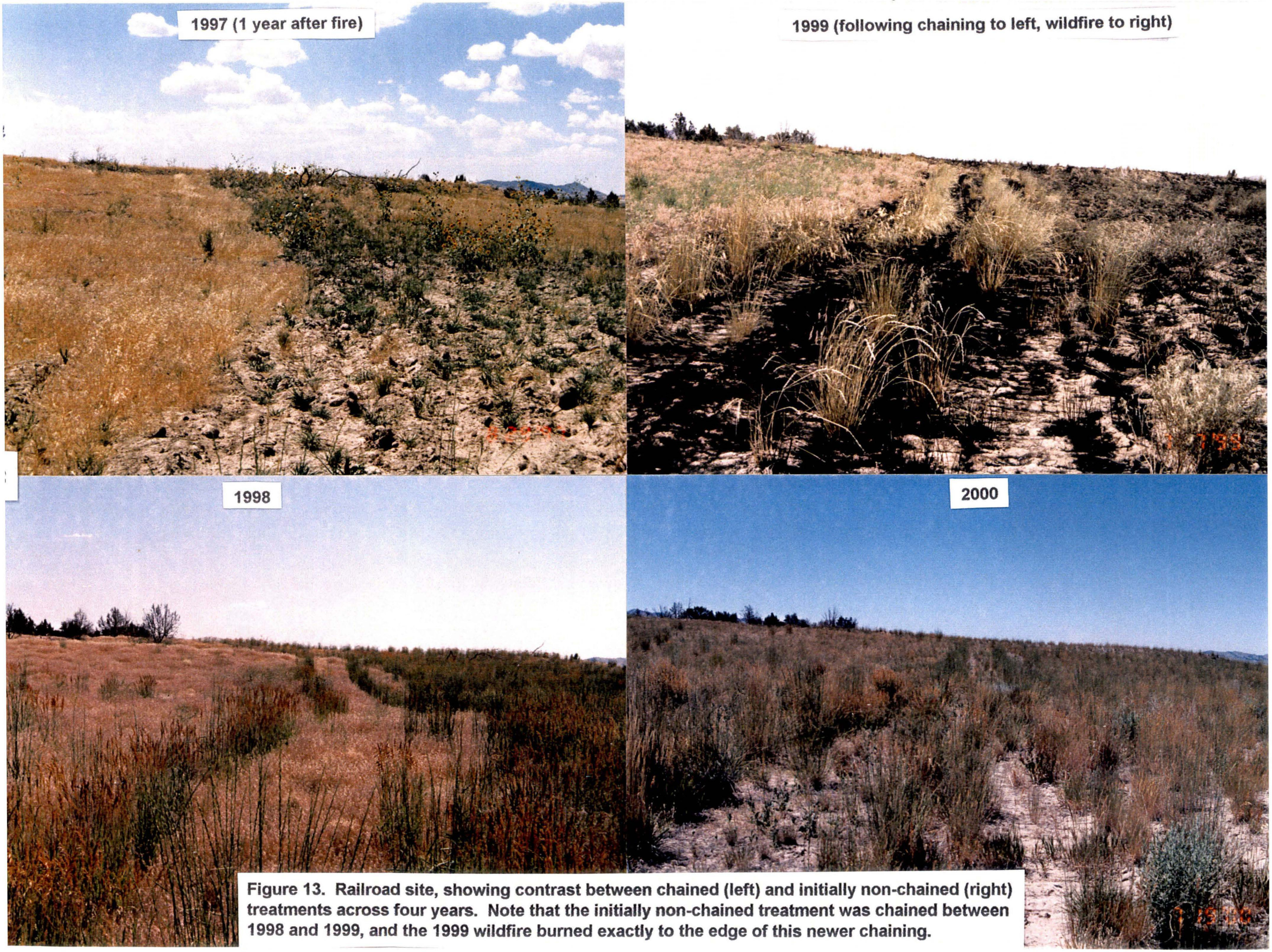
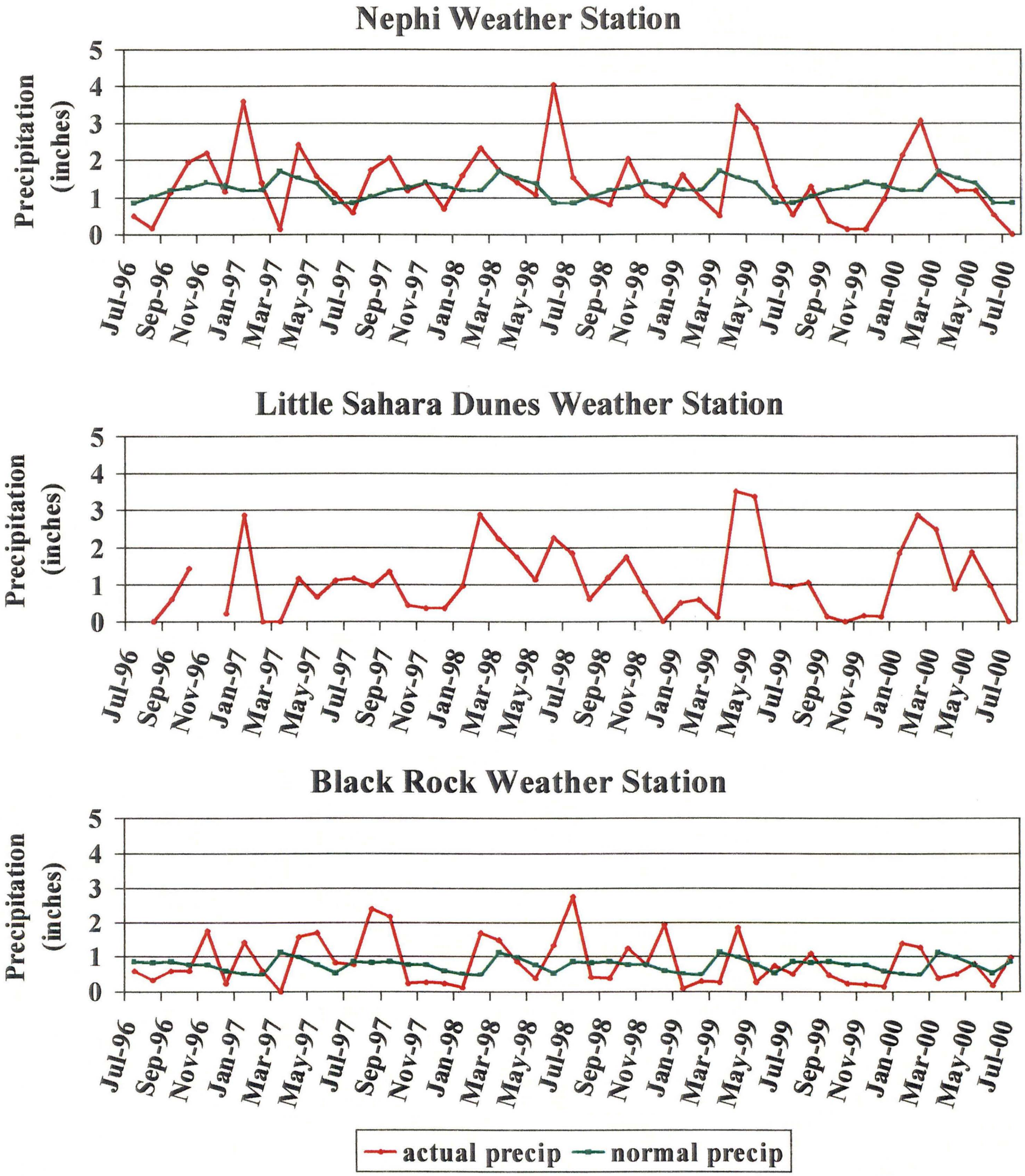


Figure 13. Railroad site, showing contrast between chained (left) and initially non-chained (right) treatments across four years. Note that the initially non-chained treatment was chained between 1998 and 1999, and the 1999 wildfire burned exactly to the edge of this newer chaining.

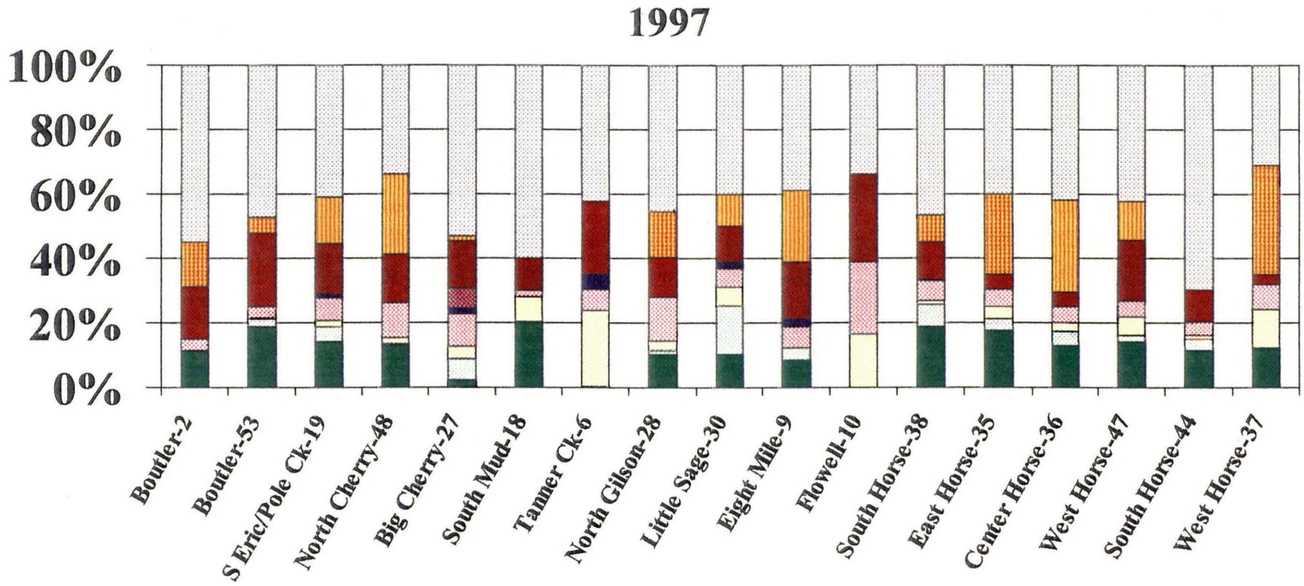
Figure 14. Montly precipitation data from weather stations in vicinity of study sites, July 1996-July 2000



Source: National Oceanic and Atmospheric Administration

Figure 15 (a). Mean percent cover of categories by treatment, site, and year, based on 100m² plots of Extensive Study (see Table 11). Sites are arranged from north (right) to south (left).

a. Chained Treatment



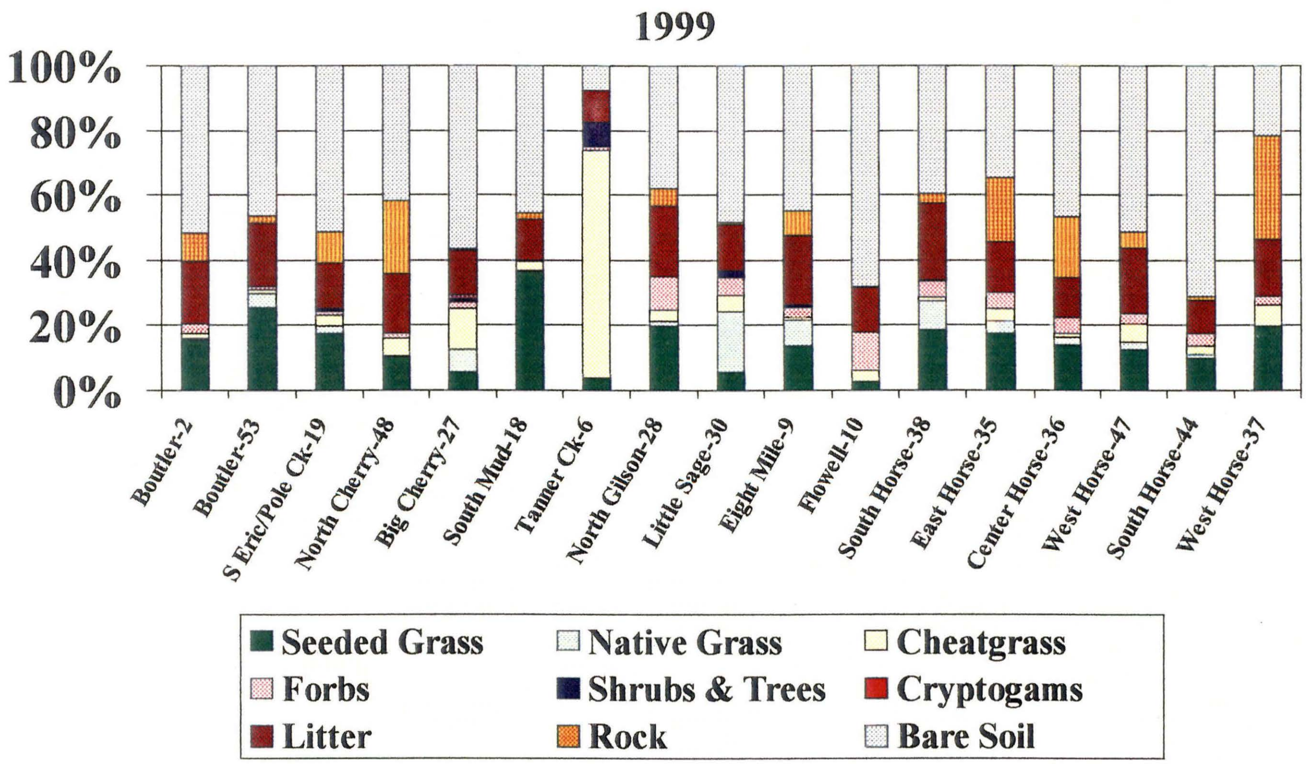
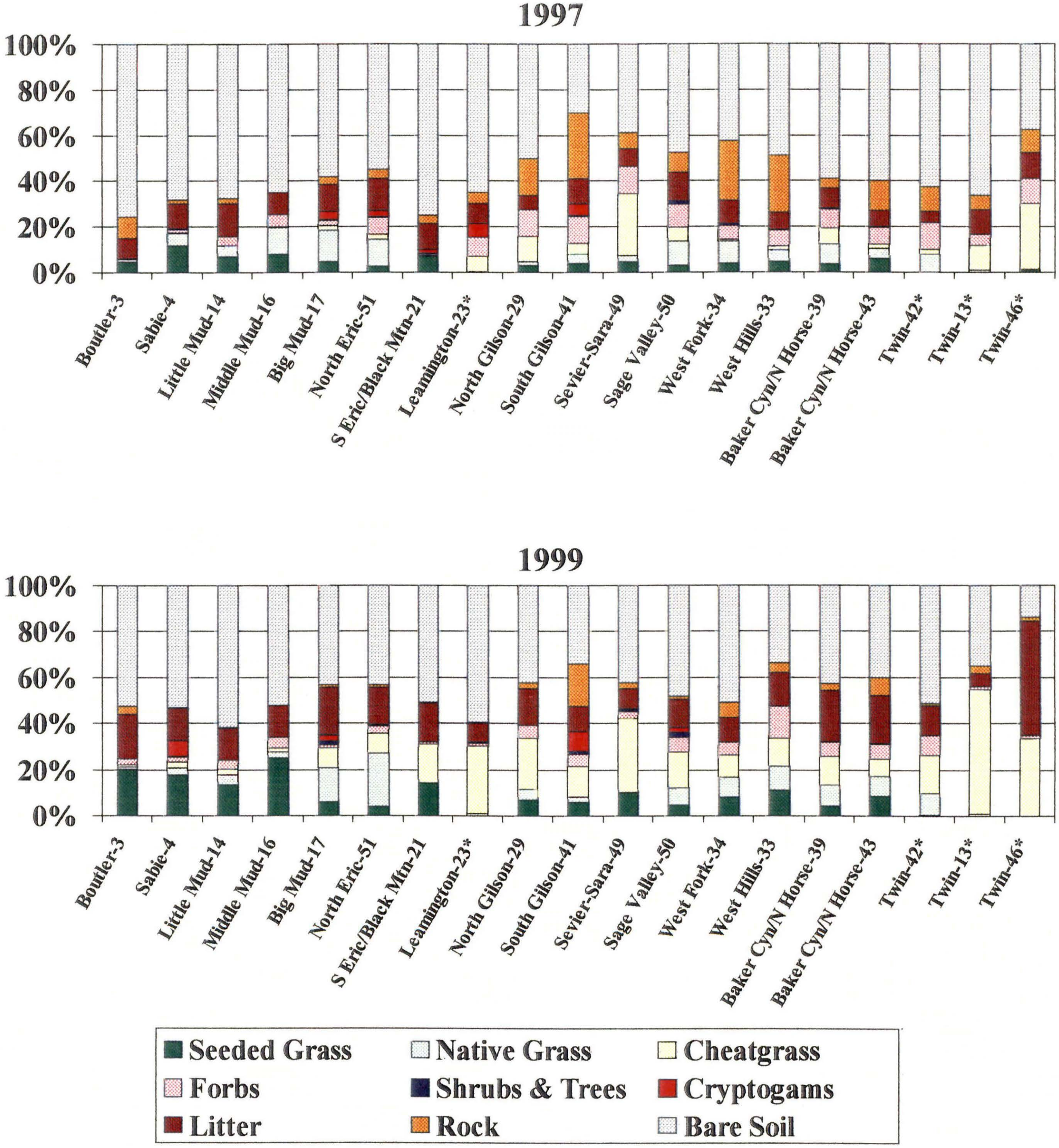


Figure 15 (b). Mean percent cover of categories by treatment, site, and year, based on 100m² plots of Extensive Study (see Tables 11, 15). Sites are arranged from north (right) to south (left).

b. Aerial-seeded and Non-seeded Treatments



*Non-seeded Sites

Figure 15 (c). Mean percent cover of categories by treatment, site, and year, based on 100m² plots of Extensive Study (see Table 11). Sites are arranged from north (right) to south (left).

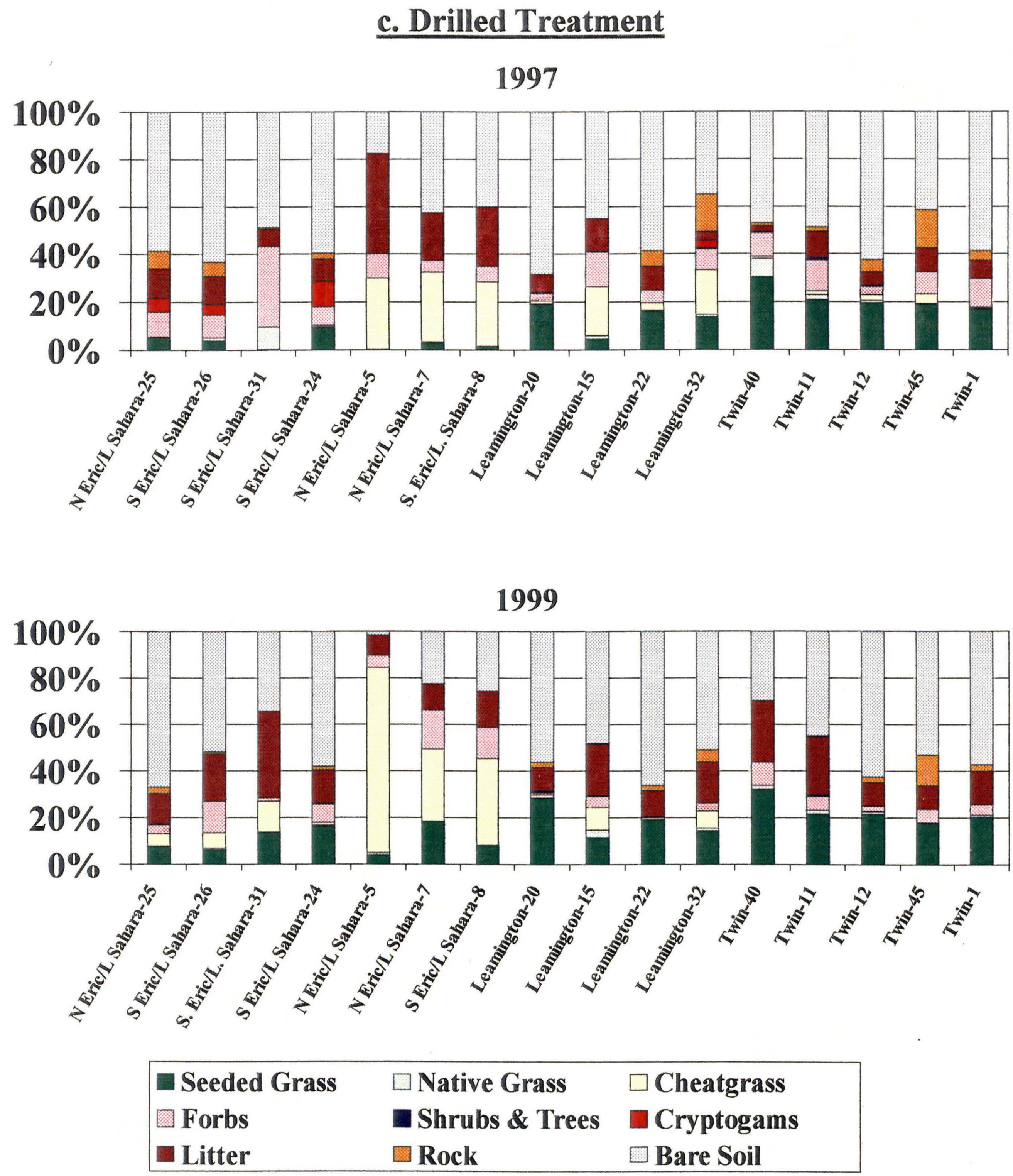
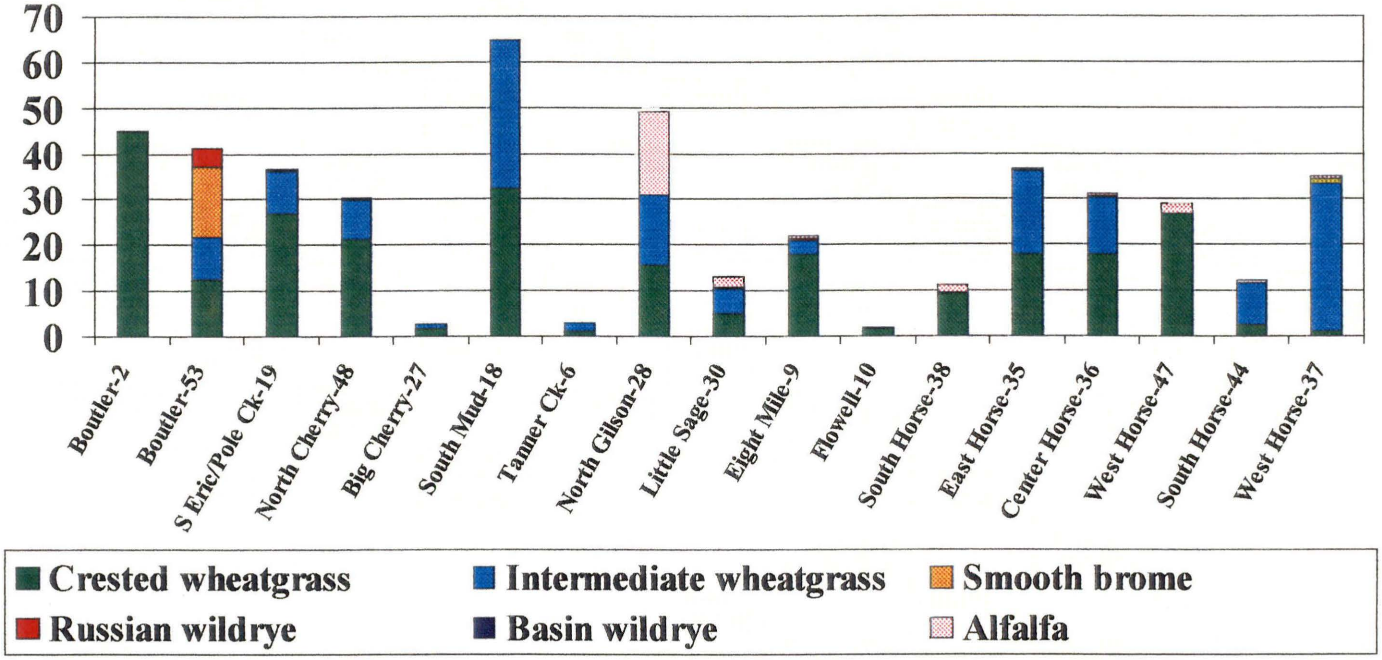


Figure 16 (a). Mean percent cover of important plants by treatment and site, based on 1999 data from 100m² plots of Extensive Study (see Tables 12-13). Sites are arranged from north (right) to south (left).

a. Chained Treatment

Seeded Grasses and Forbs



Native Grasses and Cheatgrass

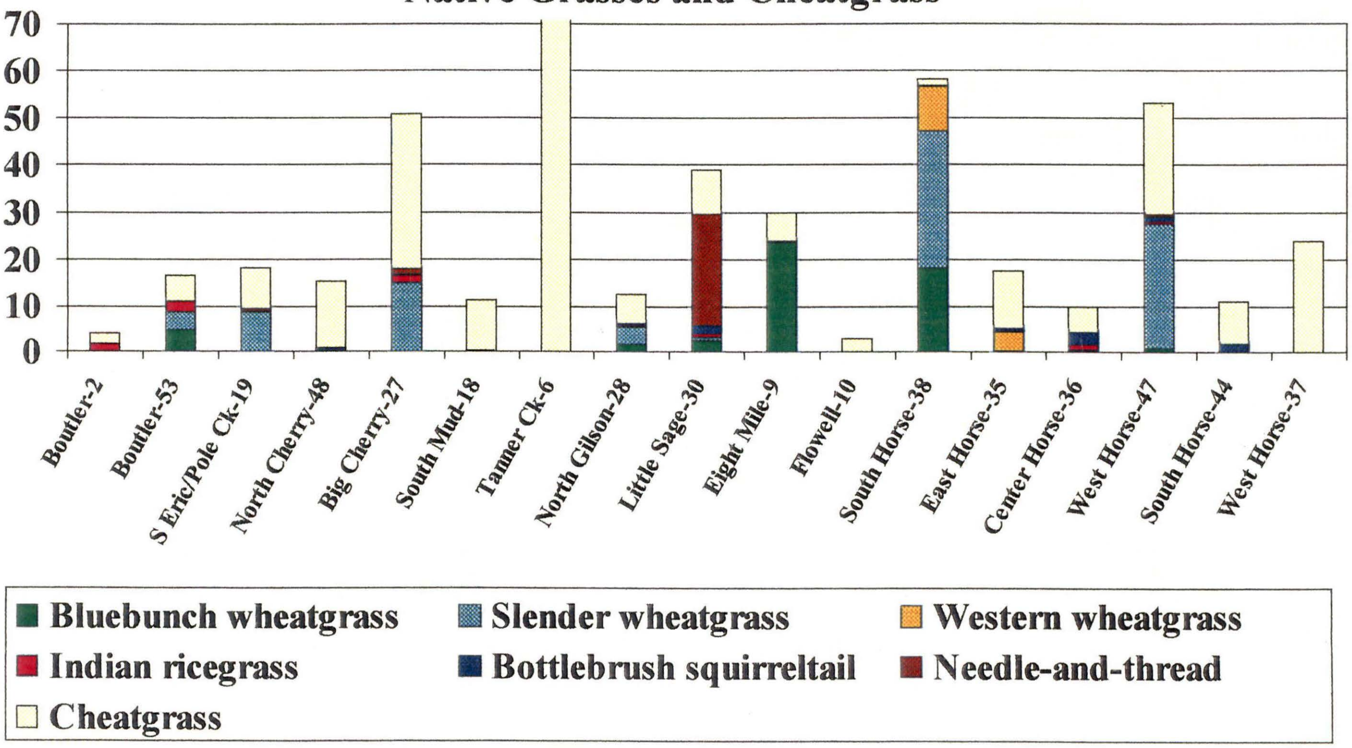
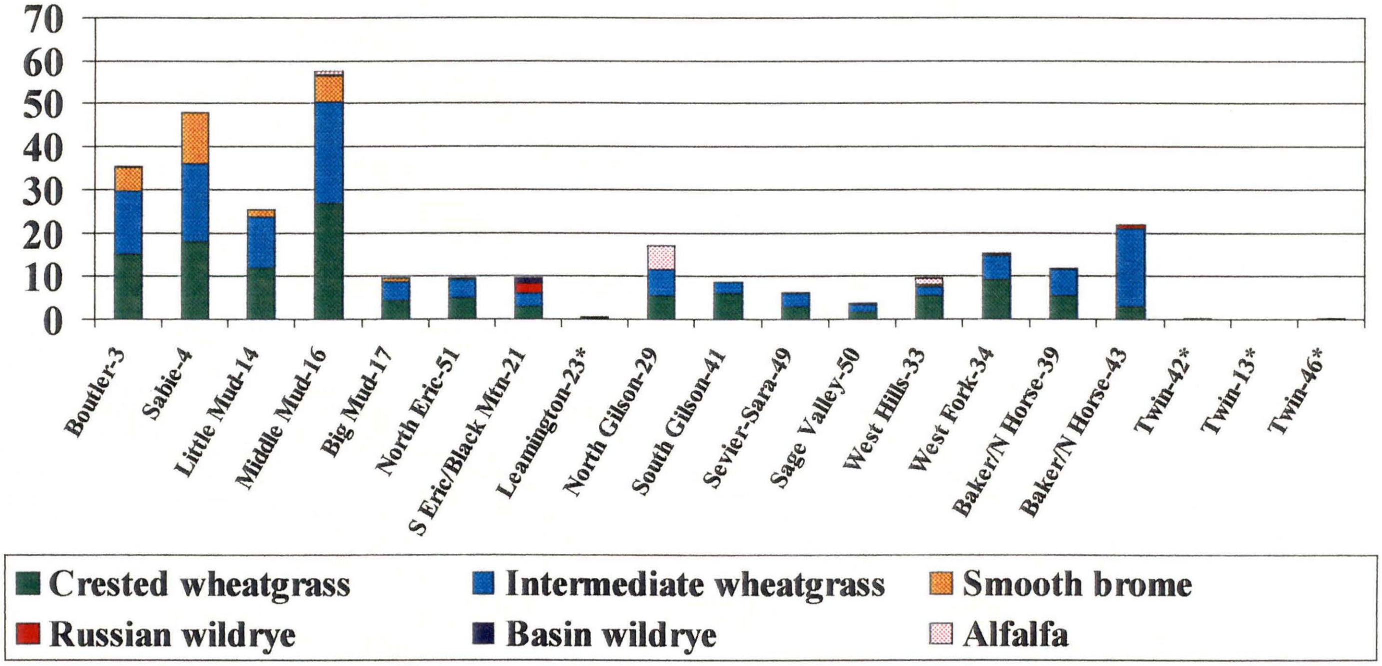


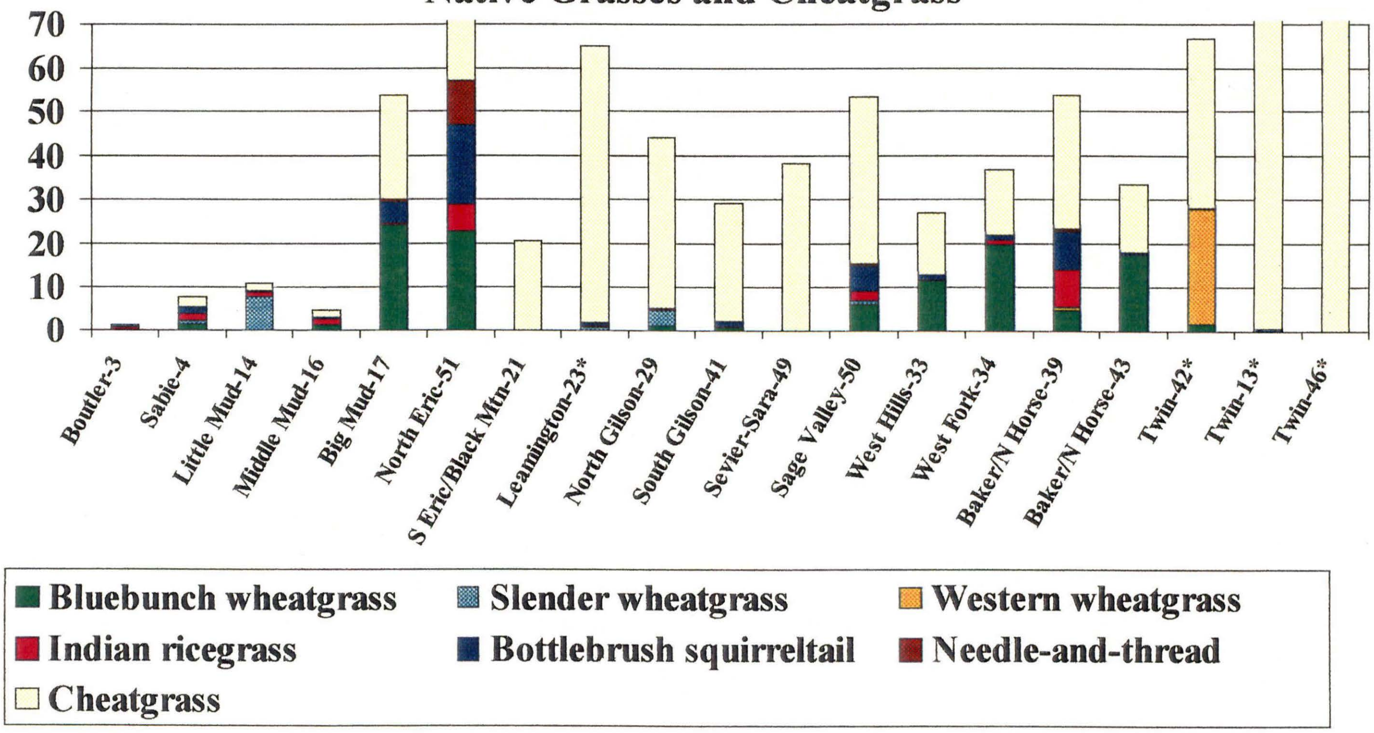
Figure 16 (b). Mean percent cover of important plants by treatment and site, based on 1999 data from 100m² plots of Extensive Study (see Tables 12-13, 16). Sites are arranged from north (right) to south (left).

b. Aerial-seeded and Non-seeded Treatments

Seeded Grasses and Forbs



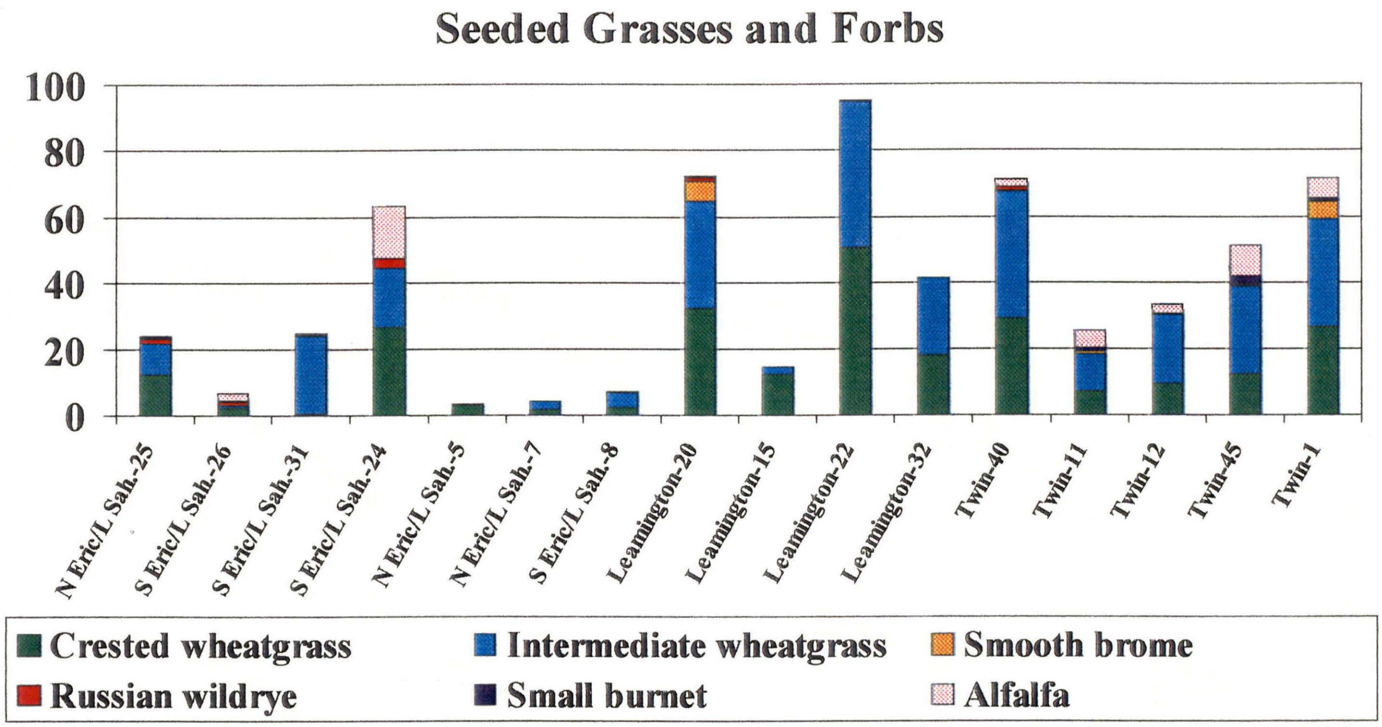
Native Grasses and Cheatgrass



*Non-seeded Sites

Figure 16 (c). Mean percent cover of important plants by treatment and site, based on 1999 data from 100m² plots of Extensive Study (see Tables12-13). Sites are arranged from north (right) to south (left).

c. Drilled Treatment



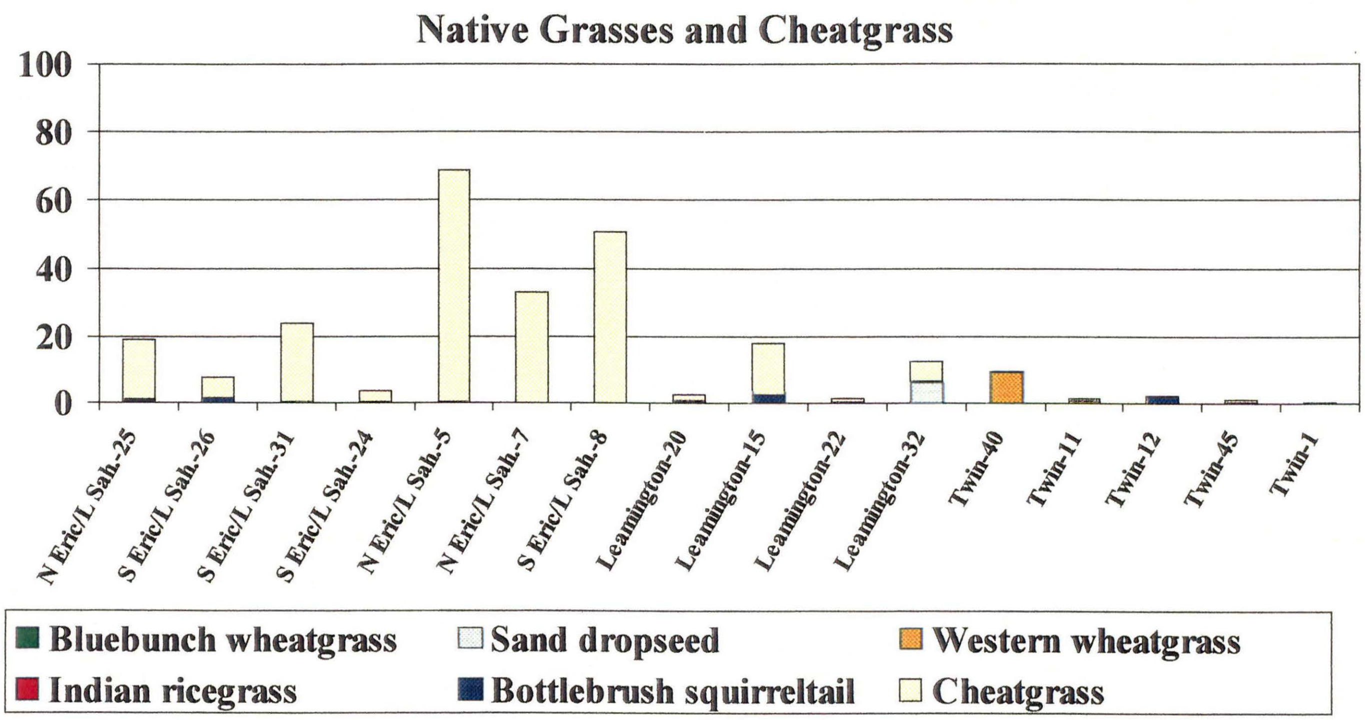


Figure 17 (a). Mean percent cover by treatment and year for Extensive Study 100m² plots, showing results of analyses of variance (GLM procedure, SAS)

a. Total Vascular Plant Cover

Means of the same color represented by the same letter were not significantly different at alpha=0.05

The interaction of treatment and year *was* significant at alpha=0.05

Note: Shapiro-Wilk statistic=0.001 following arcsine of the square root transformation

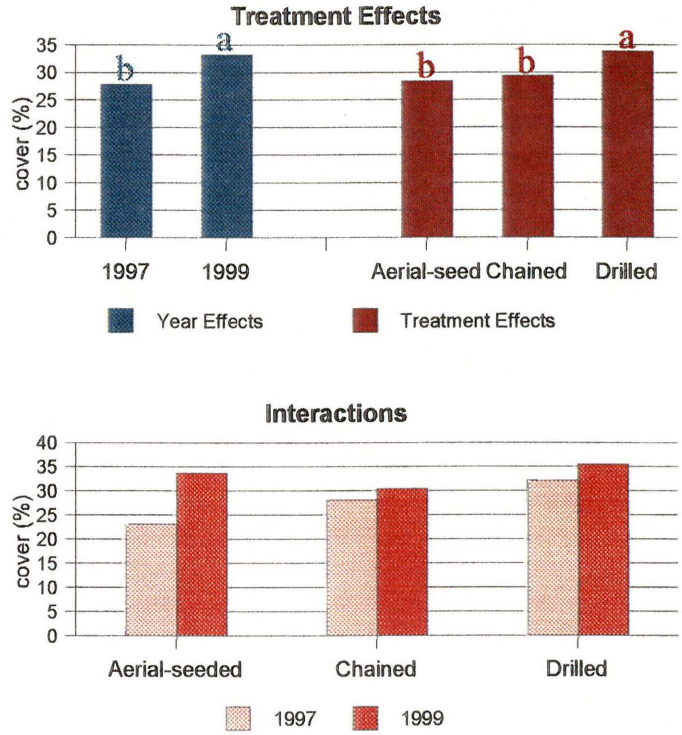


Figure 17 (b). Mean percent cover by treatment and year for Extensive Study 100m² plots, showing results of analyses of variance (GLM procedure, SAS)

b. Forb Cover

Means of the same color represented by the same letter were not significantly different at alpha=0.05

The interaction of treatment and year *was not* significant at alpha=0.05

Note: Shapiro-Wilk statistic=0.026 following arcsine of the square root transformation

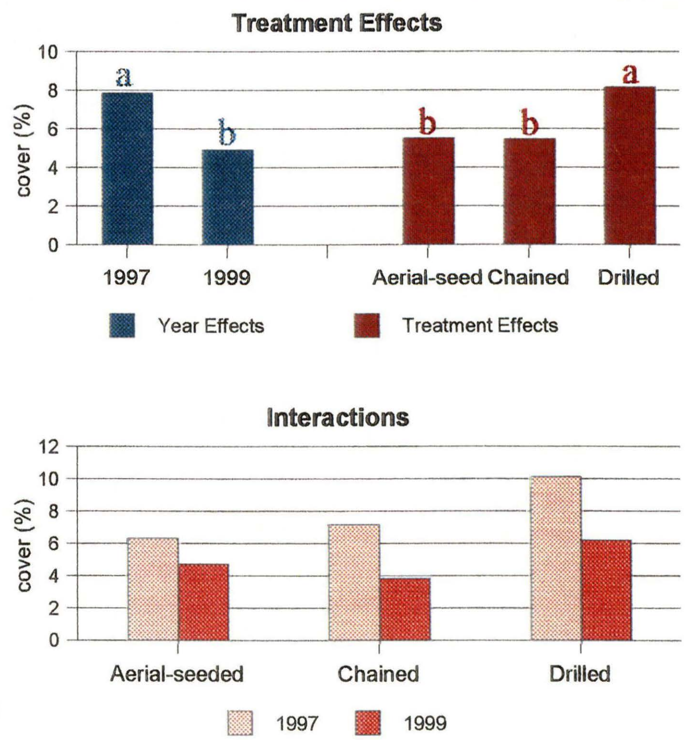
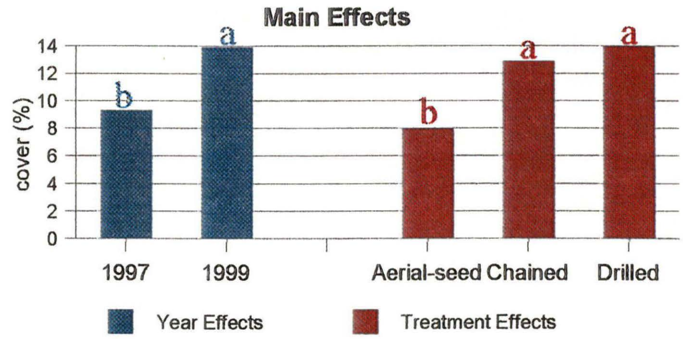


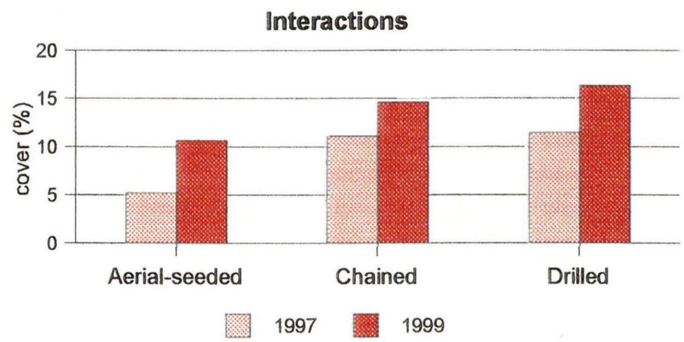
Figure 17 (c). Mean percent cover by treatment and year for Extensive Study 100m² plots, showing results of analyses of variance (GLM procedure, SAS)

c. Seeded Grass Cover

Means of the same color represented by the same letter were not significantly different at alpha=0.05



The interaction of treatment and year *was not* significant at alpha=0.05

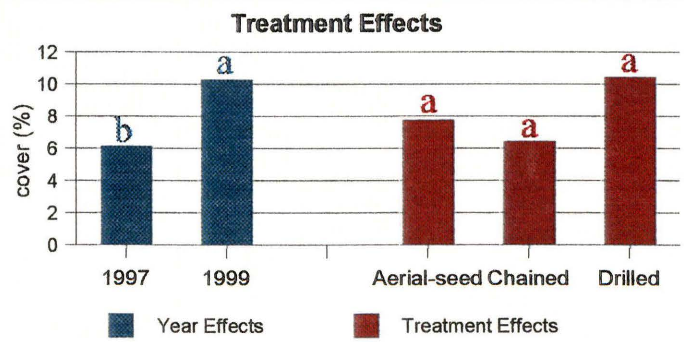


Note: Shapiro-Wilk statistic=0.001 following arcsine of the square root transformation

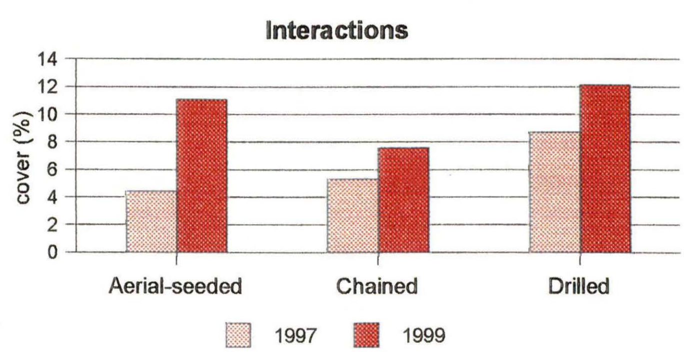
Figure 17 (d). Mean percent cover by treatment and year for Extensive Study 100m² plots, showing results of analyses of variance (GLM procedure, SAS)

d. Exotic Grass Cover

Means of the same color represented by the same letter were not significantly different at alpha=0.05



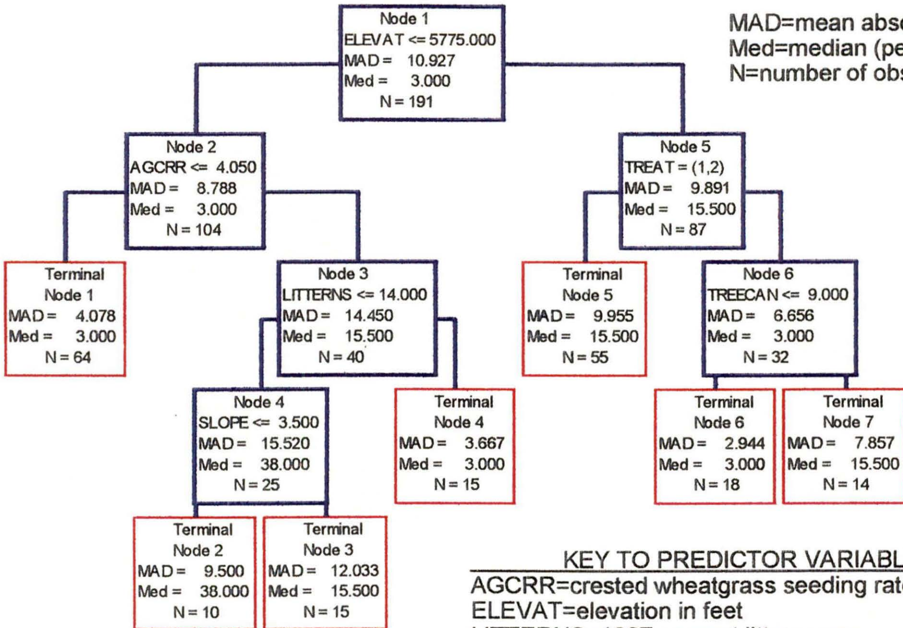
The interaction of treatment and year *was* significant at alpha=0.05



Note: Shapiro-Wilk statistic=0.001 following arcsine of the square root transformation

Figure 18 (a). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m² plots of Extensive Study.

a. Response variable=1999 crested wheatgrass cover (Resubstitution Relative Error=0.624)



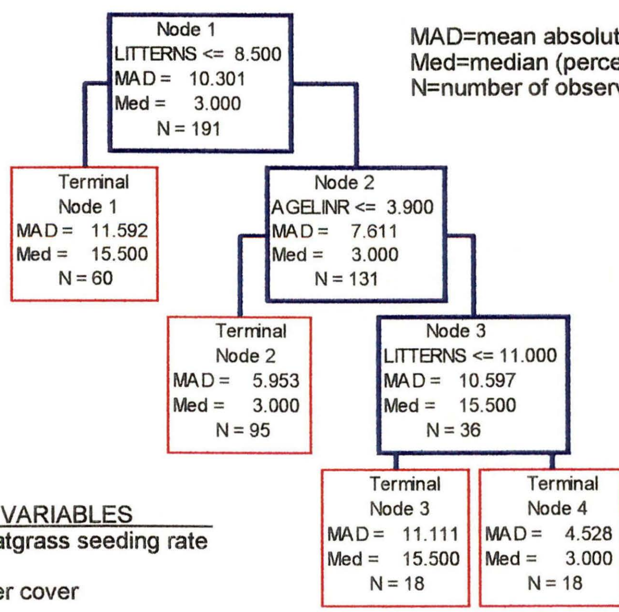
MAD=mean absolute deviation
Med=median (percent cover)
N=number of observations (plots)

KEY TO PREDICTOR VARIABLES

AGCRR=crested wheatgrass seeding rate in lbs./acre
ELEVAT=elevation in feet
LITTERNS=1997 percent litter cover
SLOPE=percent slope
TREAT=treatment (1=chained; 2=drilled; 3=aerial-seeded)
TREECAN=percent dead tree canopy cover

Figure 18 (b). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m² plots of Extensive Study.

b. Response variable=1999 intermediate wheatgrass cover (Resubstitution Relative Error=0.784)



MAD=mean absolute deviation
Med=median (percent cover)
N=number of observations (plots)

KEY TO PREDICTOR VARIABLES

AGELINR=intermediate wheatgrass seeding rate in lbs./acre
LITTERNS=1997 percent litter cover

Figure 18 (c). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m² plots of Extensive Study.

c. Response variable=1997 seeded grass cover (Resubstitution Relative Error=0.534)

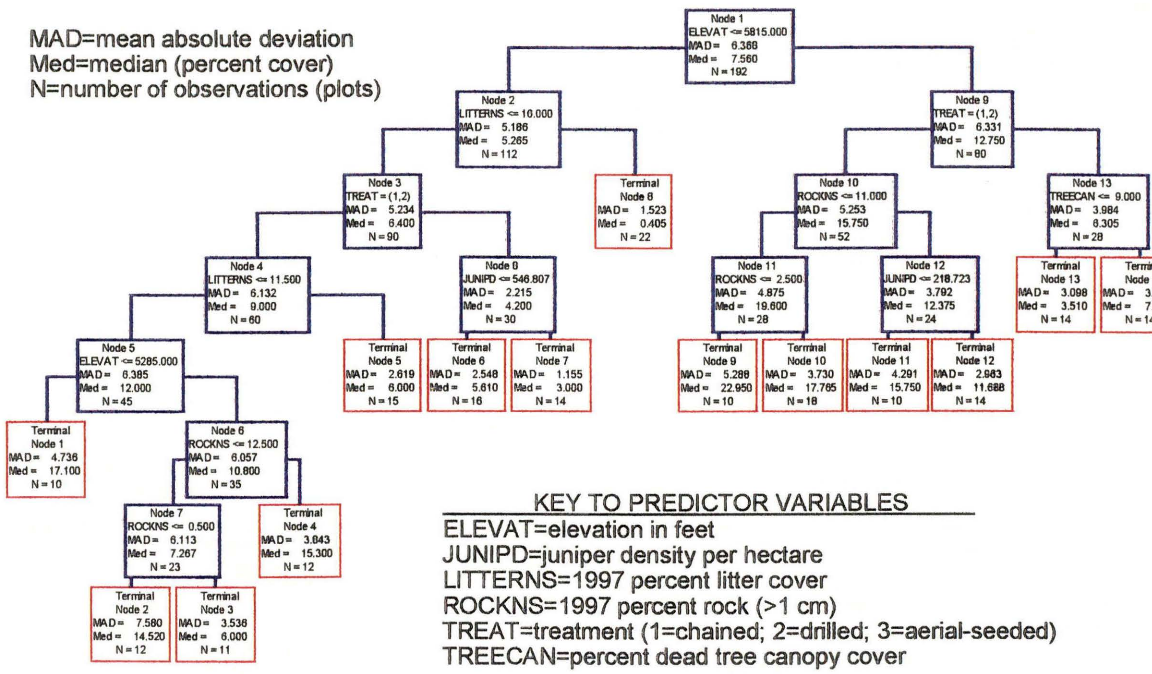


Figure 18 (d). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m² plots of Extensive Study.

d. Response variable=1999 seeded grass cover (Resubstitution Relative Error=0.767)

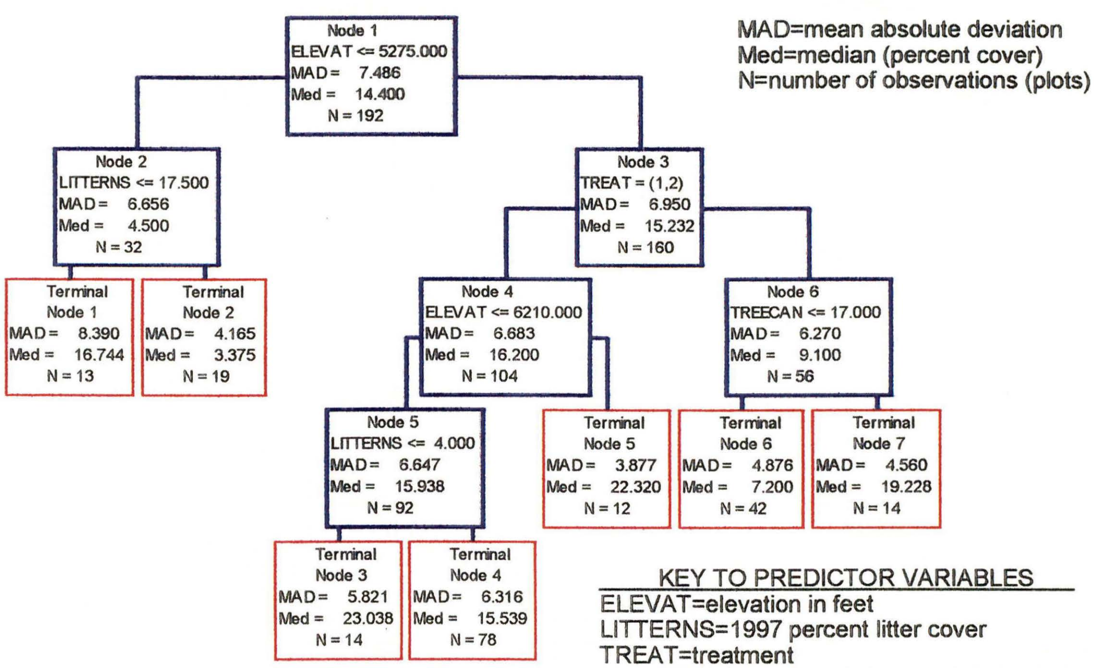
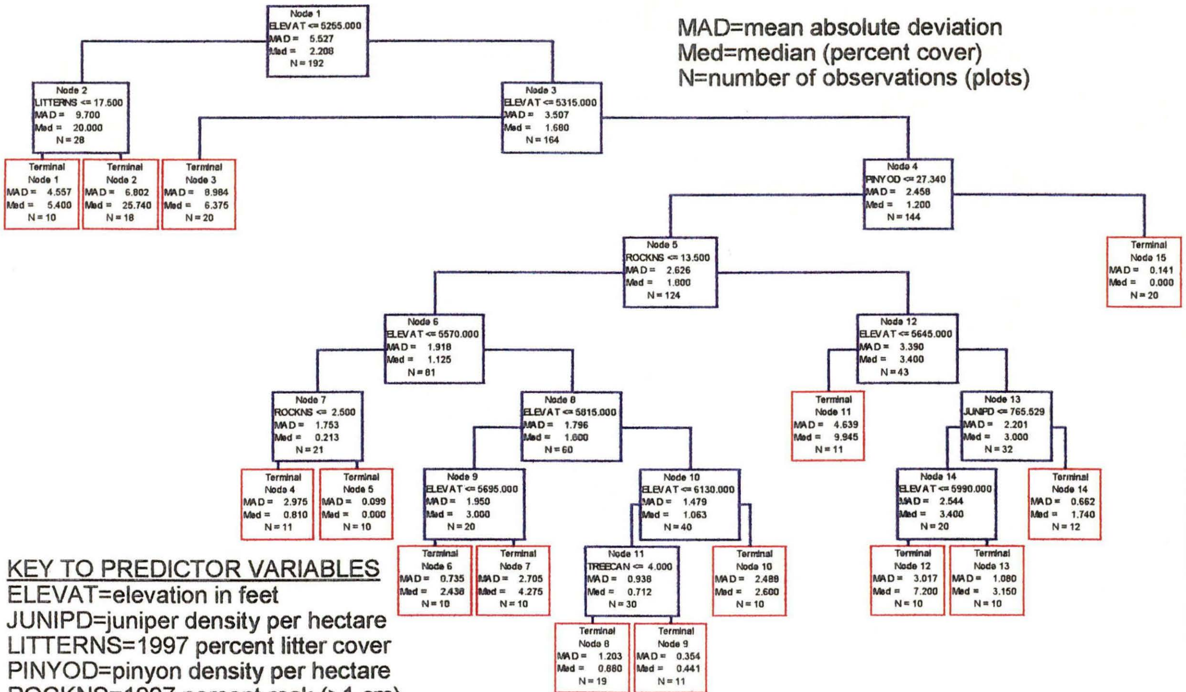


Figure 18 (e). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m^2 plots of Extensive Study.

e. Response variable=1997 exotic annual grass cover (Resubstitution Relative Error=0.537)

MAD=mean absolute deviation
Med=median (percent cover)
N=number of observations (plots)

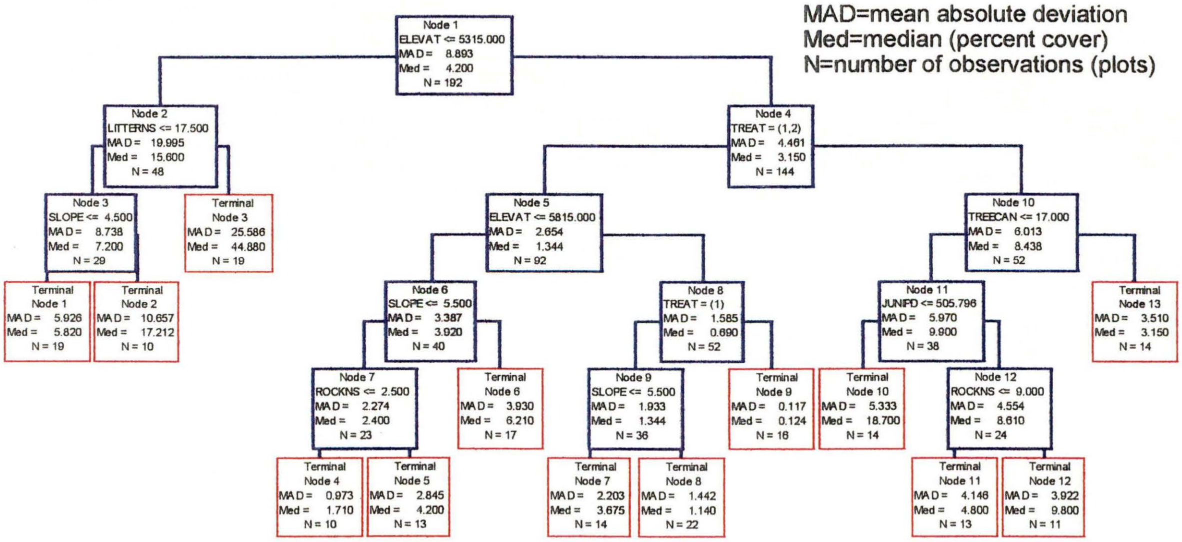


KEY TO PREDICTOR VARIABLES
ELEVAT=elevation in feet
JUNIPD=juniper density per hectare
LITTERNS=1997 percent litter cover
PINYOD=pinyon density per hectare
ROCKNS=1997 percent rock (>1 cm)
TREECAN=percent dead tree canopy cover

Figure 18 (f). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m^2 plots of Extensive Study.

f. Response variable=1999 exotic annual grass cover (Resubstitution Relative Error=0.647)

MAD=mean absolute deviation
Med=median (percent cover)
N=number of observations (plots)

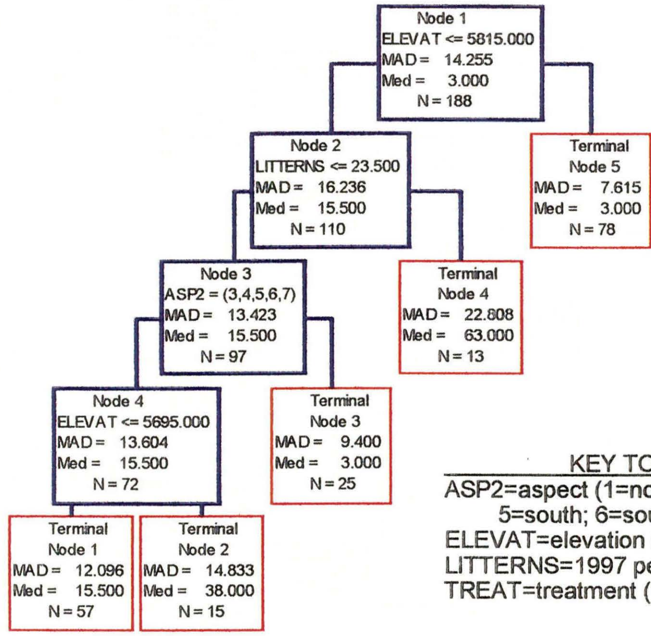


KEY TO PREDICTOR VARIABLES

ELEVAT=elevation in feet
JUNIPD=juniper density per hectare
LITTERNS=1997 percent litter cover
ROCKNS=1997 percent rock (>1 cm)
SLOPE=percent slope
TREAT=treatment
(1=chained; 2=drilled; 3=aerial-seeded)
TREECAN=percent dead tree canopy cover

Figure 18 (g). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m² plots of Extensive Study.

g. Response variable=1999 cheatgrass cover (Resubstitution Relative Error=0.760)



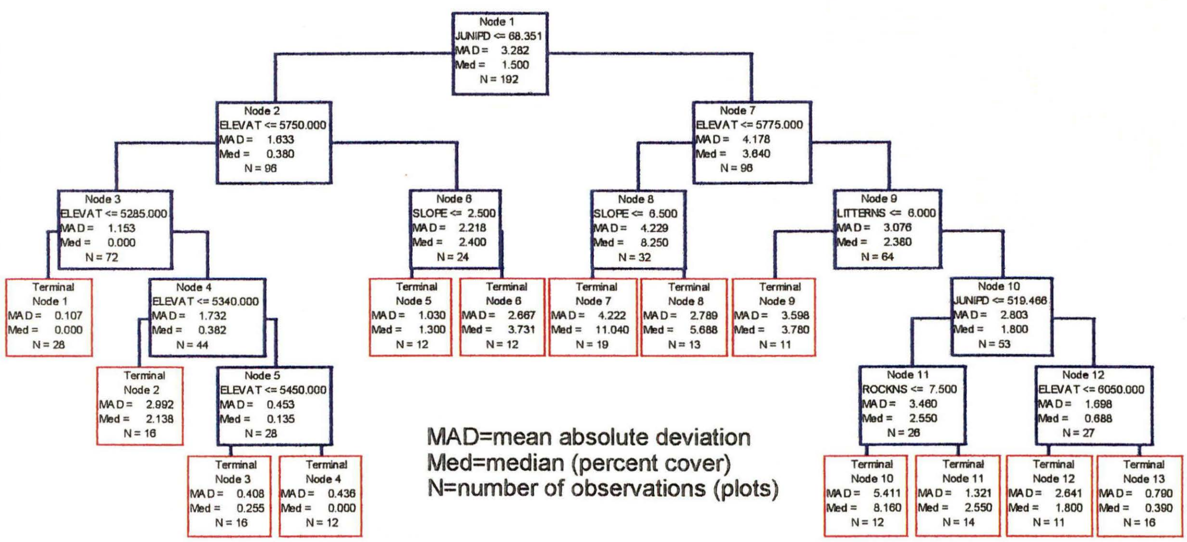
MAD=mean absolute deviation
Med=median (percent cover)
N=number of observations (plots)

KEY TO PREDICTOR VARIABLES

ASP2=aspect (1=north; 2=northeast; 3=east; 4=southeast; 5=south; 6=southwest; 7=west; 8=northwest)
ELEVAT=elevation in feet
LITTERNS=1997 percent litter cover
TREAT=treatment (1=chained; 2=drilled; 3=aerial-seeded)

Figure 18 (h). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m² plots of Extensive Study.

h. Response variable=1997 native grass cover (Resubstitution Relative Error=0.616)

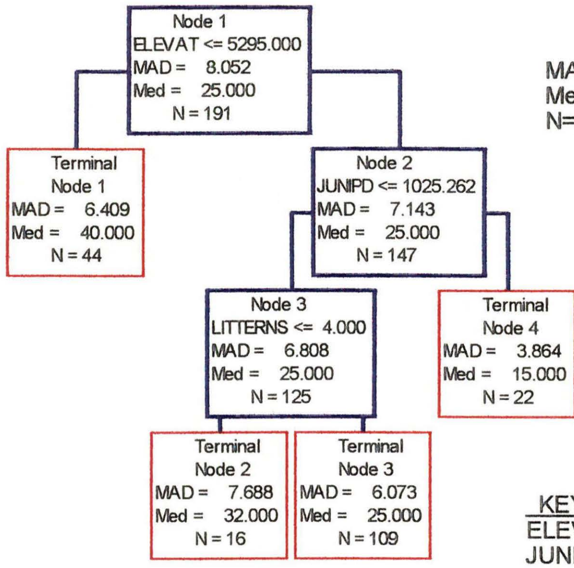


KEY TO PREDICTOR VARIABLES

ELEVAT=elevation in feet
JUNIPD=juniper density per hectare
LITTERNS=1997 percent litter cover
ROCKNS=1997 percent rock (>1 cm)
SLOPE=percent slope

Figure 18 (i). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m² plots of Extensive Study.

i. Response variable=1997 total vascular plant cover (Resubstitution Relative Error=0.749)

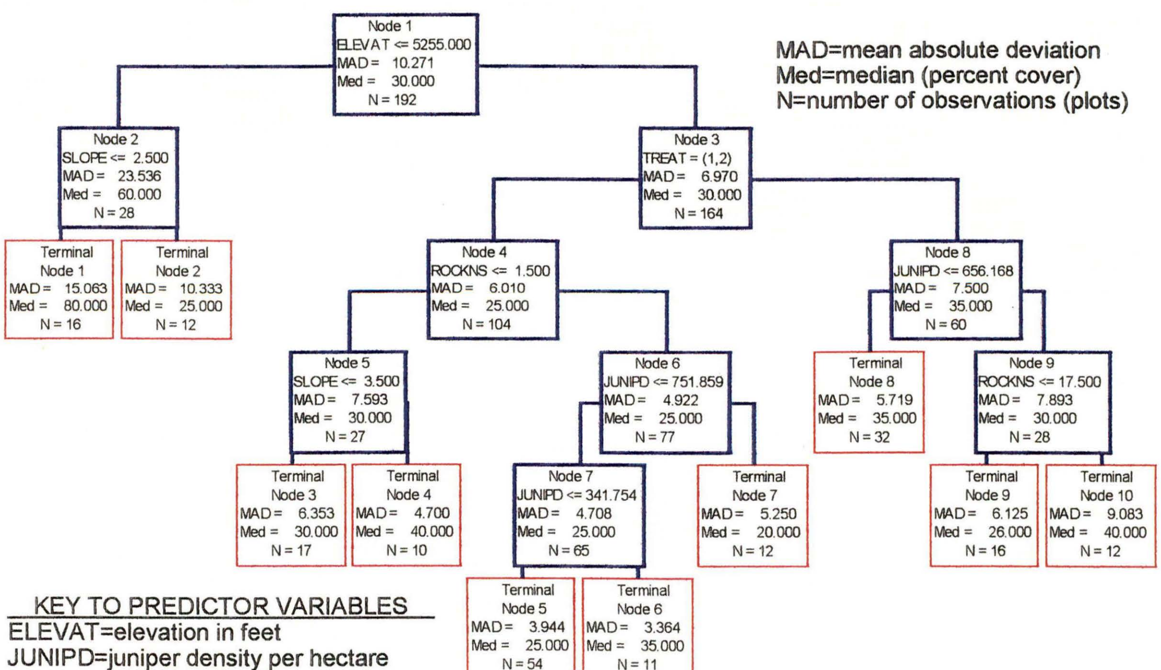


MAD=mean absolute deviation
Med=median (percent cover)
N=number of observations (plots)

KEY TO PREDICTOR VARIABLES
ELEVAT=elevation in feet
JUNIPD=juniper density per hectare
LITTERNS=1997 percent litter cover

Figure 18 (j). Classification and Regression Trees (CART least average distance procedure) of cover responses on rehabilitated 100 m² plots of Extensive Study.

j. Response variable=1999 total vascular plant cover (Resubstitution Relative Error=0.620)



MAD=mean absolute deviation
Med=median (percent cover)
N=number of observations (plots)

KEY TO PREDICTOR VARIABLES
ELEVAT=elevation in feet
JUNIPD=juniper density per hectare
ROCKNS=1997 percent rock (>1 cm)
SLOPE=percent slope
TREAT=treatment (1=chained; 2=drilled; 3=aerial- seeded)